THE EFFECTS OF CHANGES IN FOREST COVER

ON

INFILTRATION RATES

A Comparative Study in Forested Water Supply Catchments

by

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ORIGINALITY OF THESIS

Except where specific acknowledgement is given, this thesis is my original work.

U Sein Win

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ABSTRACT

The results of field measurements to assess the effects of changes in forest cover on infiltration rates are reported.

In the Pierce's Creek forest in the Australian Capital Territory measurements were made using infiltration rings in eucalypt forest and *Pinus radiata* plantation on both granite and shale soils. The results indicate no substantial change in the infiltration characteristics as a consequence of conversion from eucalypt to *Pinus radiata* plantation.

In the Kyetmauk-taung catchment in central Burma measurements were made in a mixed deciduous forest, a plantation and semi-indaing forest. The plantation was established on land resumed as a catchment protection measure following deterioration by erosion under cultivation for bananas. There were significant differences between the infiltration characteristics of the three forest types. The results indicate that the infiltration characteristics of the plantation area have after seven years recovered to values comparable with the adjacent relatively undisturbed forest.

At both study areas estimates of cumulative infiltration derived from the field measurements are compared with rainfall totals for corresponding time intervals.

The measurements of sorptivity in the Kyetmauk-taung catchment, using procedures after Talsma (1969), are related to gravimetric moisture contents. It is suggested that sampling of gravimetric moisture content on a catchment basis would provide estimates of the seasonal variation of sorptivity for hydrologic modelling of the infiltration process. No relation was found between sorptivities and gravimetric moisture content in the measurements made in the Australian Capital Territory.

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CHAPTER I

THE STUDY IN OUTLINE

1.1 INTRODUCTION

Changes in forest cover have been associated with changes in both the total and the rate of water yield from catchments. Serious erosion problems have emerged in some localities with the removal of forest cover, particularly where the removal has been by burning for shifting cultivation purposes.

The effects of changes in forest cover on water yields cannot be predicted with accuracy but much study is in hand toward providing the understanding and information which will enable reliable predictions based on knowledge of both the physical characteristics of the catchment and the hydrologic processes associated with rainfall-runoff relations.

In this study the effect of changes in forest cover on the magnitude of infiltration rates is investigated. Infiltration rates are compared with rainfall intensities to enable an assessment of the significance of the changes in forest cover in relation to the frequency of occurrence of ponding and overland flow.

1.2 INFILTRATION IN FORESTED CATCHMENTS

Wissopakan (1977) found few reported studies of infiltration with specific reference to forested catchments but there is a voluminous literature on infiltration. A review of forest management practices and infiltration in forested catchments is presented in Chapter II.

1.3 INFILTRATION THEORY

There has been continued development of the infiltration theory since the presentation of a general theory of water movement in porous media by Buckingham (1907). A review of infiltration theory is presented in Chapter III together with the theoretical basis of the methods used in this study to determine estimates of infiltration rates based on field measurements.

1.4 THE STUDY SITES AND OBJECTIVES

The field measurements for this study were taken in two very different situations where the changes in forest cover had been quite drastic.

In the Cotter river catchment of the Australian Capital Territory the effect on infiltration rates of a change from *Eucalyptus* to *Pinus radiata* plantations was investigated and infiltration rates under stands of both species compared with rainfall intensities to enable assessment of the magnitude and frequency of occurrence of rainfall excess.

In the Kyetmauk-taung catchment in central Burma infiltration rates under three different types of forest cover were investigated, viz. mixed deciduous forest, plantations (old banana plantations) and semi-indaing forest. Rainfall intensities for a limited period were also measured to enable preliminary comparisons of infiltration rates with rainfall rates.

The study areas and the selection of the sites is described in Chapter IV. Field measurement procedures and results for infiltration rates are in Chapter V. The determination of rainfall intensities is described and the results presented in Chapter VI. The results are reviewed and summarized in Chapter VII.

CHAPTER II

FOREST MANAGEMENT PRACTICES AND INFILTRATION IN FORESTED CATCHMENTS

2.1 INTRODUCTION

Many workers have suggested that a suitable ground cover is of prime importance for the protection of catchments from soil erosion. Anderson and Trobitz (1960) suggested the covering mantle should preferably be woodland because it retards runoff and, in producing a steadier flow of streams, lessens the risk of damage by excessive flood. Rothacher *et al.* (1967), Rich *et al.* (1961) and Johnstone and Doty (1972) have suggested that high infiltration rates on forested catchments contributed significantly to reducing flood peaks. Changes in forest cover may therefore significantly change flood peaks and the associated rate of erosion in catchments.

Thus when planning controls on forested catchments, particularly reservoir catchments, it is necessary to examine problems relating infiltration, runoff and erosion and knowledge of infiltration rates and capacity is essential in taking steps to rehabilitate a deteriorating catchment.

2.2 INFILTRATION AND THE FOREST COVER

2.2.1 Introduction

Infiltration, or the downward entry of water into soil, is one of the more important processes in the soil phase of the hydrologic cycle. Horton (1939) describes infiltration as a process where water soaks into or is absorbed by the soil.

Infiltration is affected by vegetation and the greater the amount of vegetation cover the higher the infiltration (Musgrave, 1935; Rowe, 1955; Arend, 1942; Johnson, 1940; Packer, 1951).

The vegetation cover operates in several ways. By shielding the surface from impact it maintains the important crumb or aggregate structure which is essential to higher infiltration rates. The roots open channels in the soil for transmission of water. The mulch formed by annual shedding of foliage is an important ingredient in the soil building process. Finally soil moisture is extracted by vegetation through the process of transpiration and creates a moisture deficiency or storage potential which assists infiltration when moisture is available.

Infiltration is thus of importance both for crop management in agriculture and forestry and for many purposes of catchment management. The soil and vegetation cover should be manipulated to control the entry of water into the soil.

2.2.2 Factors affecting infiltration

Lewis and Powers (1938) listed a large number of factors affecting infiltration and divided them into two major groups,

(1) those factors influencing the infiltration rate at a given time and point such as texture, structure and organic matter,

(2) those factors influencing the average infiltration rate over a considerable area and period of time such as slope, vegetation and surface roughness.

Horton (1940) suggested the following generalized factors affecting infiltration rate,

- soil type and profile

- biologic and microstructure within the soil
- vegetal cover.

While at that time some workers were of the opinion that infiltration rate was governed solely by the soil mass and therefore largely independent of surface conditions or microstructure at or close to the soil surface, Horton considered that infiltration rate was governed mainly by conditions at or near the soil surface.

Wisler and Brater (1949) outlined a number of factors affecting and determining the infiltration capacity. These factors include,

(1) the moisture content of the soil,
(2) the shrinking or swelling of the colloidal material in the soil,
(3) the effect produced by rain upon the soil surface,
(4) changes in macrostructures resulting from animal borings, the decay of vegetal roots, sun-checking, and the dissolution of minerals,
(5) condition of the vegetal cover,
(6) cultivation,
(7) compression of entrapped air,
(8) temperature changes.

They suggested that 'infiltration capacity' was affected by all these factors as a result of the changes produced in the effective sizes of the openings through which water enters the surface strata of the soil.

The qualitative description of factors by the abovementioned authors makes it clear that the infiltration process is complex in theoretical terms. The theory is discussed in Chapter III.

The results of studies on infiltration are reviewed in following sections in relation to the nature of the vegetation cover and soil physical factors. These two generalized factors are subject to manipulation in catchment management practices.

2.2.3 Infiltration studies in forests

Linsley, Kohler and Paulus (1949) suggested that the effect of vegetation on infiltration capacity was difficult to determine directly for vegetation intercepts rainfall and thus changes the rate at which water arrives at the ground and also the disposition of the water. However, effects of vegetation cover on infiltration have been investigated by many workers.

The importance of vegetation in promoting infiltration was shown by Michelson and Muckel (1937) in experiments on the spreading of water. The cover slowed down the movement of water over the ground surface thus giving additional time for water to enter the soil surface. The effect of ground cover vegetation on infiltration by retardation of surface flow was also studied by Arend (1942), Johnson (1940) and Rowe (1955). In general they all found that the greater the amount of vegetal cover the higher the infiltration.

While the reported studies of infiltration in forests are considerably less than those on agricultural lands there are a number of discussions and experimental investigations in connection with the effects of forests and forest management practices. As with other vegetation types forests can increase infiltration rate by (FAO, 1963),

(a) Mechanical protection of the soil from raindrop splash whereby aggregate structure is maintained and clogging of pores is prevented.

(b) By slowing down surface runoff and increasing the time for infiltration.

(c) By the root activity which acts to increase the permeability of soils.

Musgrave (1935) compared the rainfall, surface runoff and infiltration on forest and abandoned land. The results are shown in Figure 2.1.

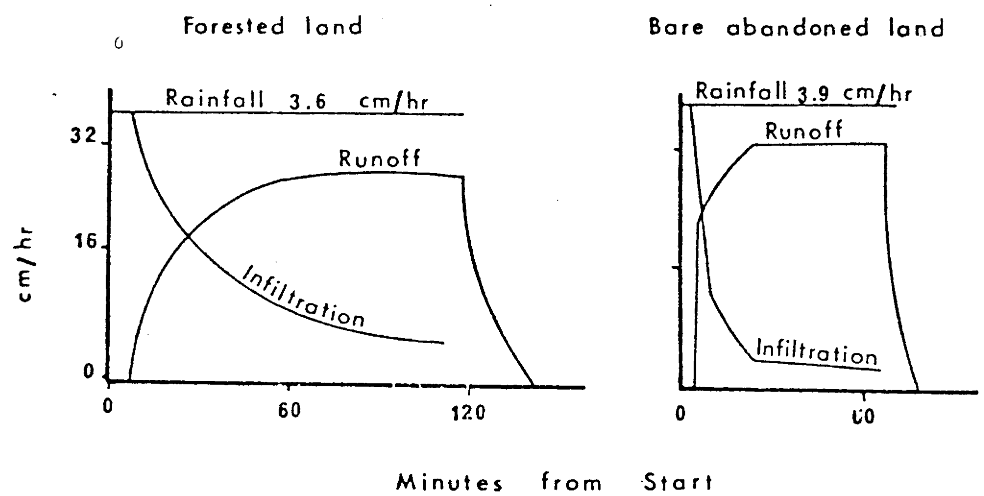


Figure 2.1 Rainfall, surface runoff and infiltration on forested land and on bare abandoned land.
(After Musgrave, 1935)

Rowe (1941) found that a forest soil covered by Ponderosa pine and Douglas fir in an undamaged condition had an infiltration rate over thirteen times that of denuded areas.

Woodward (1943) found higher infiltration capacities for brush than for herbaceous types.

Kittredge (1948) investigated infiltration in plantations and found greater infiltration in dense than in open plantations, greater in old than in young plantations and greater in unthinned and lightly thinned stands than in heavily thinned stands.

Raeder Roitzsch (1968) reported that infiltration was also influenced by the type of plant cover and gave relative infiltration rates as follows for different covers,

Oak forest	100%
Afforestation (pine on old field)	95%
Oak forest after burning	25%
Open range land	22%

Many workers, Kittredge (1948), Jenny (1941), Volobuev (1963), Glinker (1965), Russell (1973), Molchanov (1963), Gilmour (1965), Hamilton (1964) and Thistlethwaite (1970) found that infiltration differs with species and age and condition of the forest stand. Penman (1963) reported many instances of the greater infiltration rates of forests relative to pastures or clean cultivated crops.

The root activity associated with trees is a significant factor in developing high infiltration rates under forests. Different tree species have different root development characteristics and produce different penetration effects into the soil although the pattern of root growth of a species also varies with the soil condition. Some roots are so strong that they can penetrate even quite compact subsoils (Russell, 1958). However, Vasil'ev (1954) indicated that under forest vegetation only the surface 'A' horizon is loosened whereas the 'B' horizon is compacted.

Kittredge (1948) reached the following general conclusions,

(a) the infiltration rate under forest is higher than in bare soil,

(b) the infiltration capacity of a given soil is at a maximum under undisturbed natural forest with a well developed layer of litter,

(c) The infiltration rates in afforestation stands may be nearly as good as in the natural stands.

(d) Infiltration in dense stands is greater than in open woodland, it is often greater in old forest than in young stands, it is always better in ungrazed forest as compared with grazed forest; it is greater in unthinned or lightly thinned stands than in heavily thinned stands and always lowest in heavily grazed areas and in open fields.

(e) The difference in infiltration capacity between forest and disturbed soil can be of the order of 50:1 at the soil surface and while this is reduced in the subsoil a ratio of 2:1 may obtain at 20 cm of depth.

(f) On highly permeable soils, for example sand, the influence of vegetation on infiltration can be negligible.

2.2.4 Infiltration and soil properties

Soil formation is a function of climate, the parent material and the weathering actions. Coarse-grained soils with interaction of vegetation generally produce well structured porous soils with high infiltration potential whereas soils with fine grains usually have a less porous structure resulting in low infiltration rates.

Petersen *et al.* (1971) suggested that differences in parent material be considered before estimating soil moisture and infiltration rates. They suggested that the relative amounts of clay, sand and coarse fragments were related directly to the parent material and that hydrological processes associated with soils were affected by these materials.

Duley (1939) evaluated the surface factors affecting the rate of intake of water by soils. He observed the rapid reduction in the rate of intake by cultivated soils as rain fell on their surfaces and that this was associated with the formation of a thin compact layer at the surface through which water passed only slowly. The thin compact layer was the result of severe structural disturbance, due in part to the beating effect of the raindrop, and in part, to an assorting action as water flowed over the surface and the fine particles were fitted around the larger ones to form a relatively non-pervious seal. It was quite evident that the compact layer formed at the surface of cultivated soils during rains had a greater effect on intake of water than did soil type, slope, moisture content or profile characteristics.

Soil characteristics affect infiltration in interrelated and complex ways. Wissopakan (1977) summarized studies on the effects as shown in Table 2.1.

The theoretical aspects of infiltration will be taken up in Chapter III and related with that the effects of soil moisture content on infiltration and the significance of the property sorptivity. However in discussing the soil characteristics influencing infiltration it should be noted that sorptivity, proposed by Philip (1957) as a physical property of porous media, integrates the diverse physical properties of soil and overcomes much of the complexity associated with separately taking into account interrelated factors such as parent material, soil profile, soil surface, soil bulk density, porosity, texture and structure.

Table 2.1 Soil characteristics influencing infiltration and their effects [1)]

Soil characteristic	Effects	References
Soil surface	Infiltration depends on the roughness of the surface layers which induces ponding and consequently increases infiltration	Bruce *et al.* (1968)
Soil profile	Infiltration is controlled by the level of permeable layer where there is textural layering in the profile	Hanks & Bowers (1962)
	The deeper the A-horizon the greater the infiltration rate	Holtan (1965,1970,1971)
Soil bulk density	Small increases in bulk density decrease infiltration rate, the decrease in infiltration rate is larger at higher initial water contents which is probably an effect of lower swelling at higher initial water content	Gumbs & Warkentin (1972)
Soil porosity	Infiltration is directly related to porosity and increases with porosity	Russell (1958)
Soil texture	Infiltration is greater in sandy soil than in clay	Black (1957)
Soil structure	Improved aggregate structures of the soil increase conductivity which increases infiltration	Staple (1966)
Soil stone content	The infiltration rates are high with a high coarse fragment content	Petersen *et al.* (1971)
Soil litter	Infiltration increases with increasing amounts of ground cover	Gilmour (1968)

1) Based on Wissopakan (1977)

2.2.5 Infiltration and land management practices

Pillsbury and Richards (1954) studied the effects on infiltration rates of different amounts of ammonium sulphate and organic matter added to the soil. They found that moderate application of ammonium sulphate resulted in significantly higher infiltration rates than did urea when combined with large amounts of organic matter. They also found that infiltration rates increased progressively as the amount of surface matter increased.

Johnson (1958) tested the effectiveness of chlorination of the applied water and found that when chlorination was stopped numbers of microorganisms increased rapidly and the infiltration rate dropped sharply. Each time chlorination was resumed the number of micro-organisms declined and the infiltration rate increased. Chlorine appeared to have no lasting effect on the soil other than the reduction of soil organic matter content and coincident destruction of soil structure.

McCalla (1945) investigated the influence of products of microbial activity on soil structure and infiltration rate. He found that microbial decomposition of products of plant residues increased the infiltration rate of these soils. Johnson (1958) also evaluated the influence of the decomposition of organic residues on infiltration rate. He noted that infiltration rates were increased owing to an improvement in soil structure.

Li *et al.* (1942) determined the effect of different systems of soil management upon the physical characteristics of the soil and its moisture relationships. They found that different soil covers produced marked changes in soil organic matter level and in physical properties which in turn altered the infiltration rate and moisture status of the soil. Cultivation along with annual cover crops reduced the permeability as a more compact surface layer resulted, giving rise to poorer infiltration characteristics.

Musgrave (1935) compared the rainfall, surface runoff and infiltration on land subject to poor and good grazing management. The results are shown in Figure 2.2.

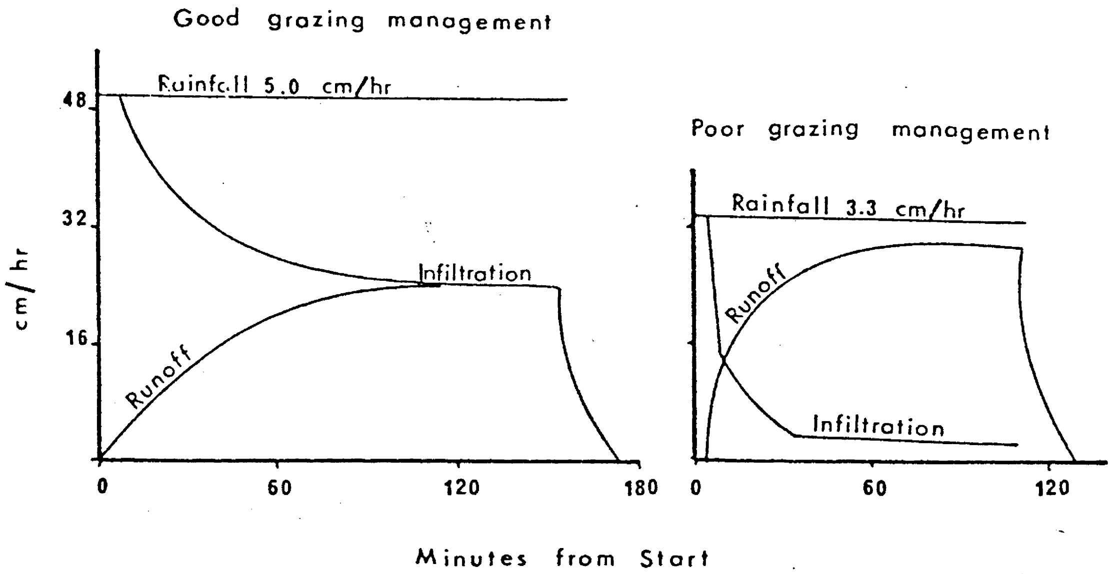


Figure 2.2 Rainfall, surface runoff and infiltration on lands subjected to good and poor grazing management. (After Musgrave 1935).

2.2.6 Summary

Forest management practices can affect infiltration rates by causing both changes in the vegetative cover and in the soil properties. The effects can be dramatic and even devastating in terms of erosion if the management practice allows total destruction of the forest.

In general, the studies of infiltration in forests have been experimental in nature and while providing some basis for qualitative assessment of management prescriptions on a catchment basis they do not suggest or assist with the quantitative prediction of effects by incorporation in, for example, hydrologic models, for the studies reported describe rather than model the infiltration process in forested catchments.

CHAPTER III

THE THEORY OF INFILTRATION AND THE DEVELOPMENT OF FIELD MEASUREMENT TECHNIQUES

3.1 INTRODUCTION

Many workers have investigated the theory of infiltration. Buckingham (1907) proposed a general theory of water movement in porous media while Green and Ampt (1911) and Gardner and Widstoe (1921) made early attempts to derive theoretically the rate or cumulative infiltration as a function of time. Since these early workers the infiltration process has been investigated in a very progressive way from qualitative observations to, in more recent years, the formulation of a widely accepted and applied theory.

3.2 INFILTRATION THEORY

Hillel (1971) describes infiltration, and Figures 3.1,3.2 and 3.3 respectively illustrate an infiltration moisture profile, infiltration as a function of time in a uniform soil in a more porous layer and in a soil covered by a surface crust, and infiltration as a function of time in an initially dry and in an initially moist soil. Figure 3.3 showing the infiltration rates as dependent on moisture content points to some of the difficulties in formulating a mathematical model of the process for as can be seen it not only depends on soil physical properties but also on moisture content. The moisture content at a point changes of course as infiltration continues and overall the soil properties

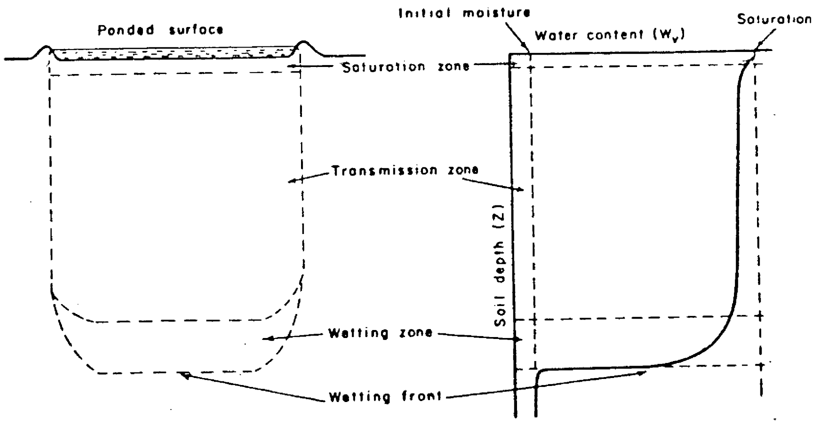


Figure 3.1 The infiltration moisture profile. At left, a schematic section of the profile; at right, the water-content vs. depth curve.

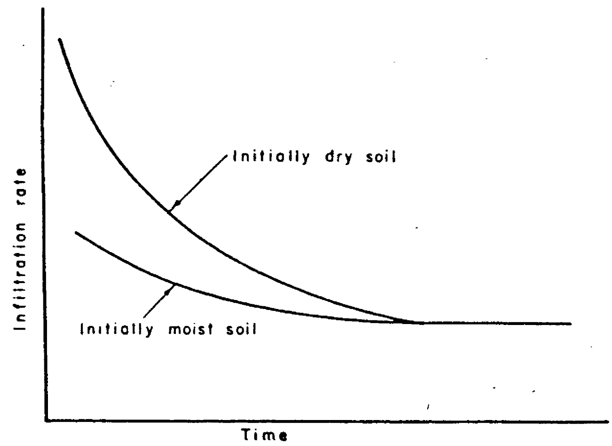


Figure 3.2 Infiltration as a function of time.

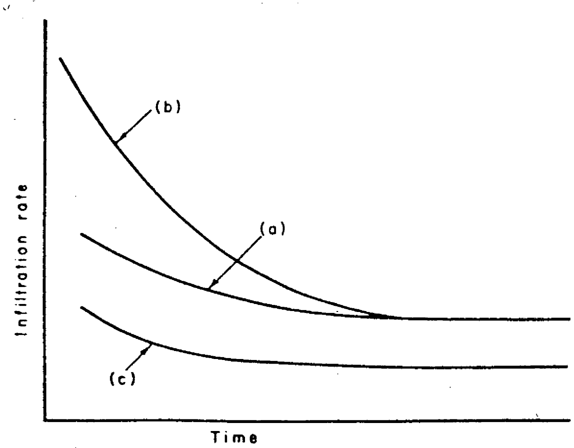


Figure 3.3 Infiltration as a function of time: (a) in a uniform soil; (b) in a soil with a more porous upper layer; and (c) in a soil covered by a surface crust.

Source: Hillel 1971 pp.134, 140, 144

determining infiltration are in a state of flux.

Wissopakan (1977) as shown in Appendix 3.1 summarized the development of infiltration theory citing Green and Ampt (1911), Horton (1933), Philip (1954), Parlange (1971) and Farrel and Larson (1972) as making significant contributions.

The work of Kostiakov (1932), Childs (1936) and Childs and Collis-George (1950) should also be noted. Kostiakov suggested the infiltration equation, discussed in Appendix 3.2, which has been the most widely used. Childs explicitly proposed the concept of soil water movement as a diffusion phenomenon. Childs and Collis-George (1950) and others, confirmed that Darcy's law may hold for the flow of liquid water in unsaturated media. The infiltration theory of Philip (1954) was adopted to simulate the infiltration process in the mathematical model of the whole catchment process, formulated as the main analytical tool of a programme initiated by the Australian Water Resources Council, to provide a better basis for estimating the runoff from ungauged catchments and at the same time a better understanding of the hydrologic cycle (Australian Water Resources Council, 1969, 1974).

Philip (1957a) presented a full analysis of infiltration based on the solution of the relevant concentration dependent diffusion equation for appropriate boundary conditions. He showed that when water is applied to a uniform soil at uniform initial water content the total infiltration can be expressed by a rapidly converging power series. He formulated the equation for total infiltration as

$$I = St^{\frac{1}{2}} + A(t^{\frac{1}{2}})^2 + B(t^{\frac{1}{2}})^3 + \ldots\ldots\ldots\ldots\ldots\ldots \quad M(t^{\frac{1}{2}})^n \qquad (2.1)$$

where I = the cumulative infiltration flux

t = the time

S = the sorptivity

A,B,C etc. are functions of moisture content.

The sorptivity is of special significance, particularly during the early stages of infiltration. It is a term after Philip (1954) and is a property of the medium with some resemblance to permeability. It was defined in a less general way by Swartzendruber *et al.* (1954).

As stated previously the definition of the term sorptivity as the integration into the one parameter of the diverse physical properties of soil has overcome much of the complexity associated with separately taking into account interrelated factors such as parent material, soil profile, soil surface, soil bulk density, porosity, texture and structure.

Philip (1954, 1957a,b,c,d,e, 1969) has reported fundamental and systematic studies of infiltration theory and developed a numerical method for solving the infiltration equation for short and intermediate times. For longer times he concluded, as have other workers, that the infiltration rate approaches a quasi-steady state with uniform moisture distribution through a considerable portion of the profile. He also showed from Equation (2.1) that, when water is applied to a uniform soil at uniform initial water content, it would be sufficient to retain only the first two terms of the series. Thus an adequate representation of vertical infiltration is

$$I = St^{\frac{1}{2}} + At \qquad (2.2)$$

The first term of the righthand side of the equation describes the contribution to infiltration arising from capillary action and the second term represents the contribution arising from gravity.

It is Equation (2.2) which was adopted to simulate the infiltration process in the mathematical model of the Australian Representative Basin Programme (Australian Water Resources Council 1969, 1974).

The infiltration rate is the differential form of Equation (2.1) and

Equation (2.2), that is

$$i = \tfrac{1}{2}St^{-\frac{1}{2}} + A \qquad (2.3)$$

where i = infiltration rate cm/sec.

3.3 THE APPLICATION OF THE PHILIP EQUATION TO THE FIELD MEASUREMENT OF INFILTRATION

Wissopakan (1977) studied aspects of infiltration in the Orroral Representative Basin and the formulation of field methods for measuring infiltration were undertaken with him. Wissopakan (op. cit.) reviewed methods for measurement of infiltration.

The Philip equation has been found useful in field studies of infiltration (Philip, 1957d; Talsma, 1969, 1974; Talsma and Parlange, 1972; Bear *et al.*, 1968; Dunin and Costin, 1970). Philip (1957d) using laboratory data of Moore (1939) found that whereas the simplified infiltration Equation (2.2) gave almost exact correspondence with the Horton equation (Appendix 3.1) while giving an indication of the reliability at small time (t) failed badly at large t. The Kostiakov equation (Appendix 3.2) gave a moderately reliable estimate at small t. The comparisons made by Philip are summarized in Appendix 3.3.

Thus, while there seemed at the time no measurements of sorptivity over a forested catchment, the Philip equation has gained a measure of acceptance for estimates of infiltration based on field measurements. Talsma (1974) studied the effect of initial moisture content on sorptivity and presented average sorptivities for various surface conditions of a catchment for early winter (moist soil) and summer (dry soil).

Table 3.1 Average sorptivities (cm.min.$^{-\frac{1}{2}}$) for different surface conditions of an experimental catchment (After Talsma, 1974)

Surface condition	Bare	Grassland	Tussocks
Moist (winter, 1969)	0.29	0.58	1.08
Dry (summer, 1969)	0.61	0.83	1.43

Talsma (1969) had studied the relationship between sorptivity and hydraulic conductivity and found that sorptivity increased as hydraulic conductivity increased, as shown in Figure 3.4.

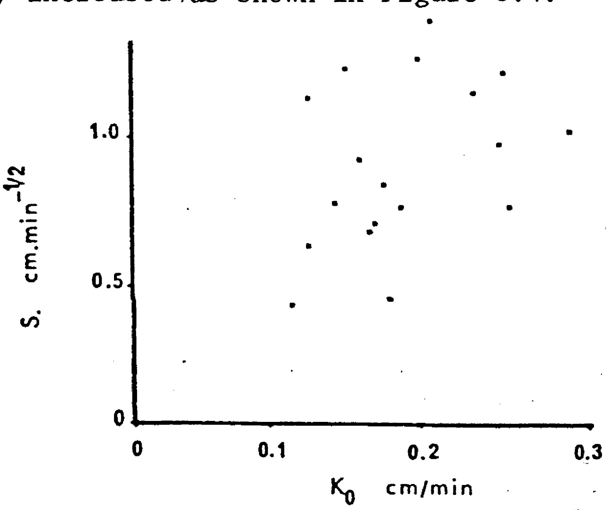


Figure 3.4 Relationship between sorptivity and conductivity (after Talsma, 1974).

Talsma (1969) measured infiltration using infiltrometer rings 30 cm in diameter, 15 cm high and pushed 10 cm into the soil. The measurements are therefore essentially of infiltration at the surface layer of soil. Talsma and Perroux (pers. comm.) provided advice, practical experience and initially loaned equipment on the 'in situ method' for measuring infiltration and this method was adopted for this study.

Talsma found that graphs of total infiltration against $t^{\frac{1}{2}}$ remained essentially linear up to 1 minute (Figure 3.5) and suggested that this represented the first term in the Philip equation, Equation (2.2), accounting for nearly all the flow for short time intervals.

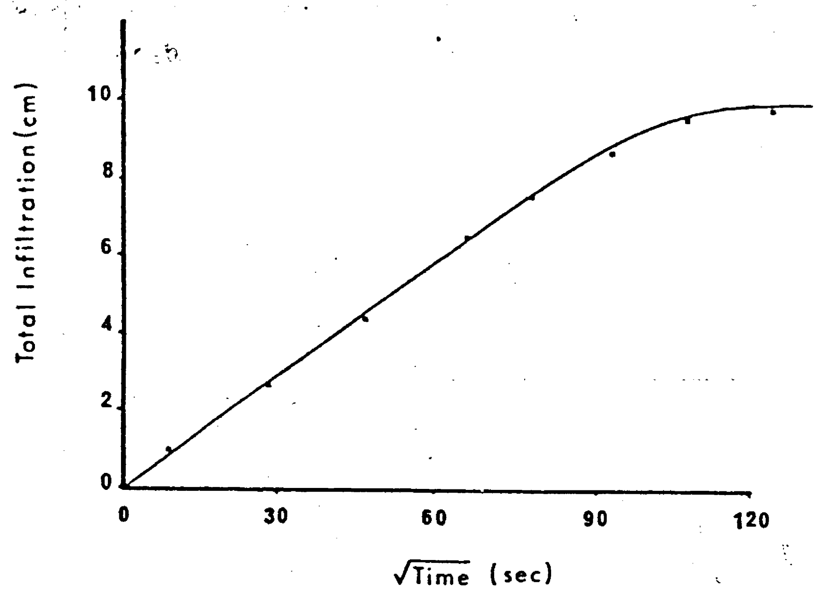


Figure 3.5 Graph shows linear portion of total infiltration against √time. (After Talsma)

On this basis the slope of the line, Figure 3.5, would give the sorptivity.

Talsma noted that sorptivity is a function of additional water storage, the hydraulic conductivity and the gradient of capillary potential across the wet front as infiltration takes place. He showed that the Philip equation (Equation 2.2) could, based on his empirical results, be reduced to

$$I = St^{\frac{1}{2}} + \frac{kt}{2.8} \qquad (2.4)$$

where I = total infiltration cm.

S = sorptivity

k = hydraulic conductivity.

It should be noted that Equation (2.4) is perhaps deceptively simple because the value of sorptivity depends on the initial moisture content and becomes a specific value for the time at which the field measurements are made.

The field procedures used to measure infiltration in this study also followed those developed by Talsma Perroux (pers. comm.) advised that they are easier and faster than most methods. The procedures are described in detail in Chapter IV.

CHAPTER IV

THE STUDY AREAS

4.1 INTRODUCTION

The Cotter catchment in the Australian Capital Territory has as its main use the supply of water to Canberra, the National Capital. The catchment was named after the settlement of William L. Cotter at the head of the catchment as early as 1832. In the period between settlement of the area and its acquisition by the Australian Government land was cleared for grazing in both the lower and upper parts of the Cotter Valley. Serious soil erosion occurred in parts of the catchment as a consequence of overgrazing and the effects of large numbers of rabbits.

A need for tree planting to rehabilitate the eroded lands was recognized as early as 1918. Planting of *Pinus radiata* commenced in 1926 and continued until 1961 when operations ceased temporarily, due partly to criticism of the apparent effects of forestry operations on water quality. A total of about 3600 hectares of pine plantation are present in the lower catchment area and these are currently managed mainly as production forests. Not all the plantations were established on eroded grazing land and the native eucalypt forest has been cleared to provide land for expanding the plantation estate.

The Australian Forestry Council after its establishment in 1964, agreed to aim for self-sufficiency in softwoods by the year 2000. An expanded softwood plantation programme was accepted by the Commonwealth and State Governments to provide a total of 1.2 million hectares by the year 2000. A high proportion of the plantation programme involves a change in forest type from eucalypt to conifer. Thus any change in soil characteristics as a consequence of plantation establishment may occur over large areas.

There has always been a strong link between protecting against erosion, water supplies and forests. For example Boughton (1970) cites Kittredge (1948) as reporting as early as 1215, Louis II of France proclaimingan ordinance entitled "The Decree of Waters and Forests". Boughton (1970) also states that in Switzerland a community reserved a forest for protection against avalanches and that between 1535 and 1777 protection forests were proclaimed in 322 instances. The extent of the proposed plantation programme in Australia generated immediate questions regarding the effects of the change in forest type on the water yields of catchments.

Several studies were put in hand, for example Smith (1974), Forestry and Timber Bureau (1974), Australian Water Resources Council (1970).

The plantation establishment programme also brought questions regarding changes in the soil erodibility characteristics as native vegetation was transformed to *Pinus radiata*. While changes in forest cover may cause changes in the inherent erodibility of the forest soils, sheet erosion is also related, inter alia, to the generation of overland flow. Thus changes in infiltration as a consequence of a change in forest cover may also have consequences in regard to the generation of sheet erosion.

Sein Thet (1975) studied 'the effects of the establishment of *Pinus radiata* on the erodibility of soils that formerly carried eucalypt forest'. He suggested that 'it is generally recognized that soils developed under forests possess a higher infiltration capacity and promote downward movement of rainfall into the soil because of litter humus layers and the presence of old root channels' and that 'without the protection afforded by plant crowns and litter in eliminating the destructive physical effects of raindrops impacting soil, the soil aggregates would be broken down, infiltration rates would decrease and increased surface runoff would result in erosion'.

Sein Thet (op. cit.) selected for study an area passing through pines and eucalypt forest growing on soils of shale and granite origin. He measured under each forest type soil parameters shown by other writers to be indices of erodibility, namely dispersion ratio, clay ratio, aggregate stability, organic matter content, particle size distribution, porosity and bulk density.

Sein Thet (op.cit.) found, on the basis of Middleton's Dispersion Ratio, that all the soils on the sites selected were erodible soils and that on the basis of indices of erodibility such as dispersion ratio, clay ratio, organic matter content and aggregate stability the soil of shale origin became more susceptible to erosion when the native eucalypts were replaced by pine.

Gilmour (1965) stated that the amount of ground cover was more important than the type of cover in controlling surface runoff on similar soils to those studied by Sein Thet (op.cit.). According to Gilmour the sites under eucalypt and pine on soils of shale and granite origin accumulated more than enough biomass of forest litter to control runoff and soil loss.

Neither Sein Thet or Gilmour, in their studies in the Cotter catchment, measured for changes in infiltration rates as a consequence of a change in cover from eucalypt to pines.

The experimental sites used by Sein Thet in the Cotter catchment were therefore chosen to initiate a study of the effects of a change in forest cover, for those sites eucalypt to radiata, on infiltration rates.

The study was continued by extension into a study of infiltration rates in the Kyetmauk-taung catchment in Burma where changes in forest cover had occurred from shifting cultivation followed by rehabilitation by reafforestation.

Due to scarcity of water in the dry zone of Burma the Government of the Socialist Republic of the Union of Burma took steps to construct dams. Planning to construct the Kyetmauk-taung dam was started in 1953. The dam was completed in 1967. Summary details are as follows.

Catchment area	360 sq km	(138.98 sq miles)
Length of dam	2590 metres	(8,500 feet)
Dam capacity	9000 hectare-metres	(73,100 acre feet)
Discharge capacity	14.6 cumecs	(520 cusecs)

Immediately after completion of the dam heavy siltation was found to be of such magnitude as to significantly reduce the anticipated life of the reservoir. The authorities took very prompt action and a policy was adopted to eradicate all banana plantations from the catchment area.

Rehabilitation of eroding areas under banana plantations was started in 1969-70. The programme was to remove banana plantations as quickly as possible and to plant these areas with suitable trees. There was thus an opportunity to examine infiltration rates in an area where sites could be selected in relatively undisturbed mixed deciduous forest, in plantations established for the rehabilitation of land occupied by banana plantations which had been established on mixed deciduous forest and in semi-indaing forests.

4.2 THE STUDY SITES

4.2.1 The Cotter catchment sites

General views in the Cotter catchment and along the selected study sites are shown in Plates 4.1 and 4.2. Specific views at the sites are shown in Plates 4.3 to 4.7.

Plate 4.1 General view along the study site

Source: Sein Thet (1975)

Plate 4.2 Plan view of the study sites

Source: Sein Thet (1975)

Plate 4.3 Eucalypt forest on granite soil

Plate 4.4 Eucalypt forest on shale soil

Plate 4.5 *Pinus radiata* on granite soils

Plate 4.6 Rewegetated pipeline track

Plate 4.7 Revegetation on pipeline track

4.2.1.1 Location

The location of the catchment and the study sites are shown in Map 4.1.

4.2.1.2 Climate

The climate of the catchment is of a continental type with summer temperatures reaching heatwave conditions about twice each year and winter temperatures frequently below freezing. Snowfalls occur almost every winter.

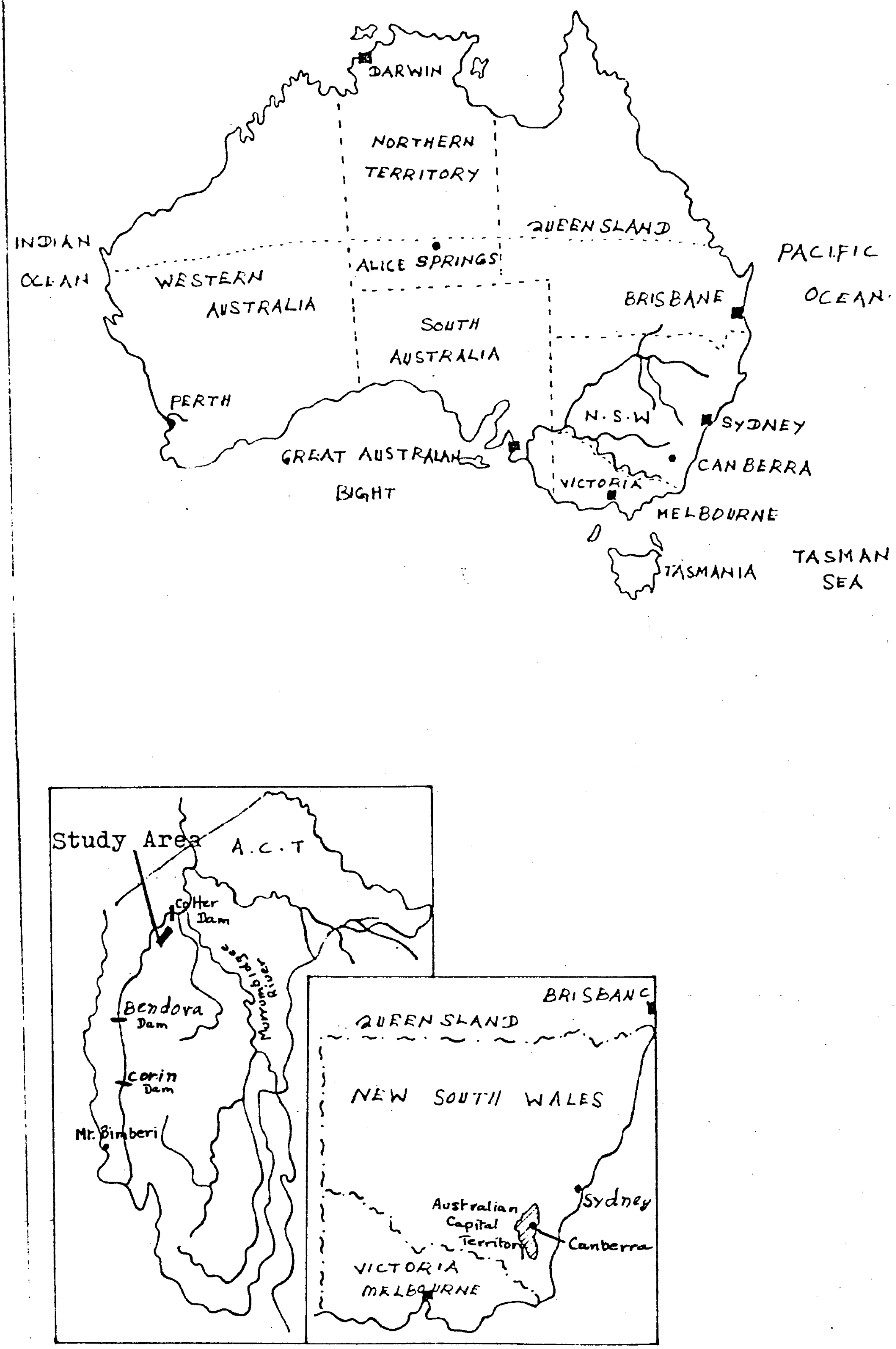
The annual distribution of rainfall within the catchment is shown in Table 4.1. Rainfall is generally more reliable in the winter and spring, but there is not much variation from month to month. A more detailed discussion of rainfall with particular reference to rainfall intensity is presented in Chapter VI. The location of rainfall stations is shown on Map 6.1.

Table 4.1 Average rainfall in lower Cotter catchment at Bulls Head, Blue Range, Uriarra 1966-1974

Month	Average Station Rainfall (mm)		
	Bulls Head	Blue Range	Uriarra
Jan.	131.7	136.8	108.6
Feb.	92.3	80.0	73.6
March	64.2	51.3	53.8
April	226.5	211.5	163.2
May	93.7	75.0	54.8
June	62.7	48.3	49.2
July	135.9	112.0	95.0
Aug.	185.8	184.5	133.5
Sept.	113.4	104.2	67.5
Oct.	169.2	153.7	130.7
Nov.	110.9	121.7	79.9
Average annual	1434.4	1366.5	1042.7

Source: Data provided by Division of Forest Research, CSIRO

MAP SHOWING STUDY AREA IN AUSTRALIA



Map 4.1 Location of the study area and the Cotter catchment

While the Watershed Research Section of the Division of Forest Research has since 1966 obtained temperature readings at their climate stations the records have not been analyzed and published. Temperature records are available for a much longer period at Yarralumla in Canberra and have been analyzed by the Bureau of Meteorology (1968). This information provides an indication of the temperature variations that occur in the catchment. Mean daily temperatures (at Yarralumla) rise above 38^{o}C about once every two years but such high temperatures rarely last for more than a few days. Maximum daily temperatures over 32^{o}C can extend for over a week. The most severe period seems to have been in January 1939 when the maximum temperature on eight consecutive days exceeded 37.8^{o}C. In January 1952 the maximum daily temperature exceeded 32.2^{o}C on eleven consecutive days.

It must be accepted that while in winter periods of heavy and sustained rainfall the soil moisture levels may approach saturation in some summer periods soil moisture levels will be very low.

4.2.1.3 Soils

Pryor (1939) recorded three main groups of soils in the Cotter catchment, red-yellow podzolics, red forest loams and alpine humus soils, and noted that their occurrence was broadly related to geology, topography and climate. The podzolics are found at elevations below 900 metres, the red forest loams on sheltered aspects up to about 1200 metres. The alpine humus soils occur in the high basin and on the gentle slopes near the crest of the Brindabella Range. The main soil types and the effects of geology and topography are discussed in 'A Resource and Management Survey of the Cotter River Catchment'.[1)]

There are two soil types, granite and shale, at the study sites (Sein Thet, 1975). They are described in more detail later.

[1)] Resource and Environmental Consultant Group, Department of Forestry, Australian National University 1973.

4.2.1.4 Vegetation

The catchment area is generally covered with mostly undisturbed forests. Open forest dominates. There are areas of tall open forest composed primarily of alpine ash and brown barrel and low open forest of broad-leaved peppermint or snow gum (Specht, 1970).

The natural eucalypt stands at the study sites are of low quality and dominated mainly by red stringybark (*E. macrorhyncha*), brittle gum (*E. mannifera*) and scribbly gum (*E. rossii*) associations. Trees of poor bole are scattered through the forest forming a stunted type of dry sclerophyll forest.

The Monterey pine (*Pinus radiata*) plantations at the study sites were established about 1935.

4.2.2 The Kyetmauk-taung Catchment Sites

The dominating feature of the catchment is Mt Poppa. A general view of the reservoir and catchment is shown in Plate 4.8 and of the slopes of Mt Poppa in Plate 4.9.

4.2.2.1 Location

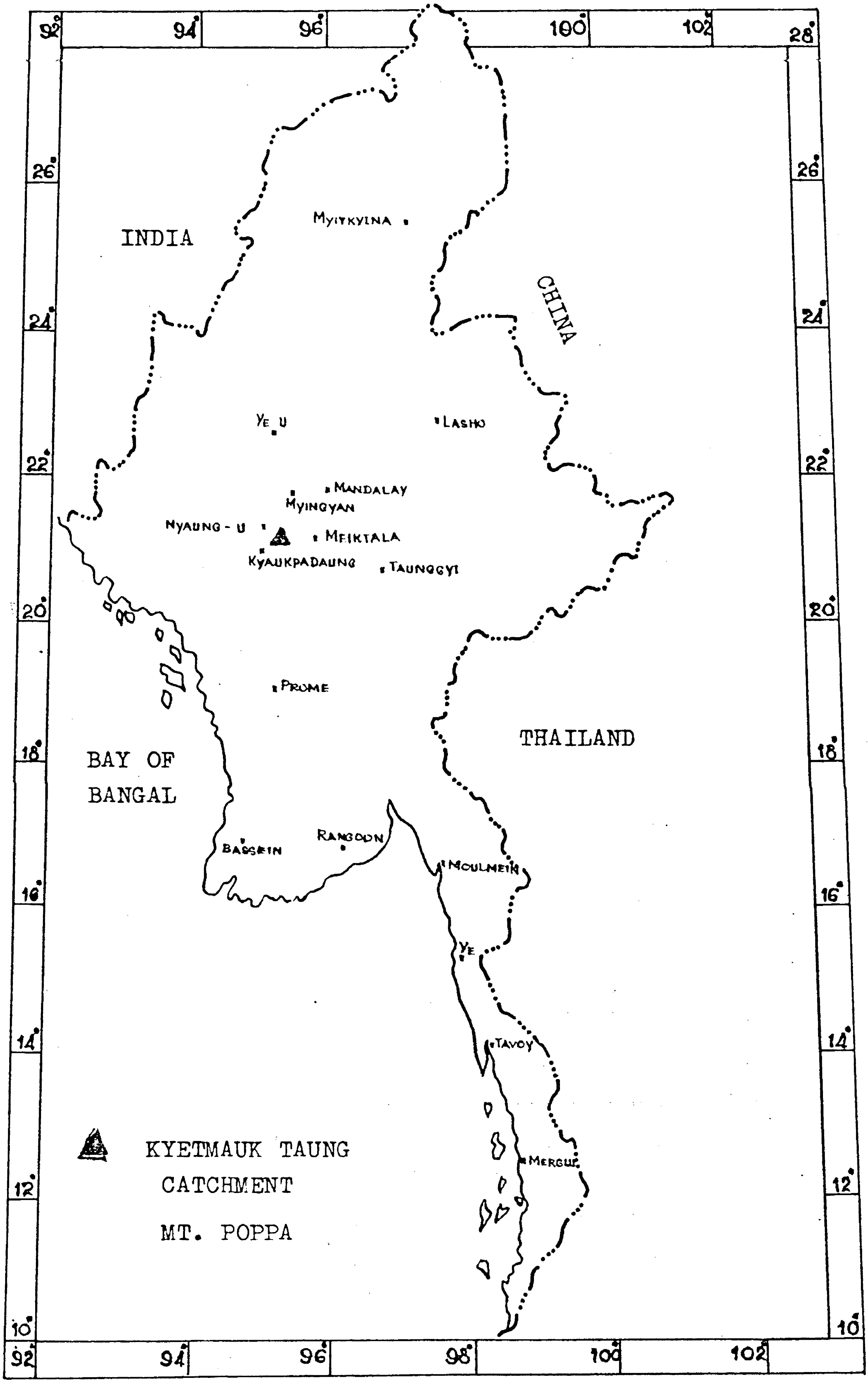
The location of the catchment is shown in Map 4.2.

The catchment lies in the dry zone of Burma, between north latitudes of 20°45.6' and 20°55.8' and east longitudes of 95°55' and 95°20.1'. It covers almost the whole of the southwest, southern and southeastern aspects of Mt Poppa where the two main streams of the catchment, the Kyauk-pon and the Taung-zin rise.

The area of the catchment is 360 square kilometres (138.98 square miles) of which 83 square kilometres (32 square miles) is

Plate 4.8 Mt Poppa and Kyetmauk-taung reservoir

Plate 4.9 Southern slopes of Mt Poppa



Map 4.2 Location of study area in Burma

reserved forest. The reserved forest was extended in 1969-70 mainly for the purpose of providing improved protection to the Kyetmauk-taung catchment. Previously there were only two small reserved forests, Poppa Hill Reserve, 1198 ha, and Poppa extension, 2123 ha.

4.2.2.2 Climate

The climate is characterized by a small rainfall and high temperatures.

Mr Poppa has a considerable effect upon the rainfall in its locality. Places north and west of the mountain receive less rain than south and east, Mr Poppa itself having a heavier rainfall than any other place in the nearby plains. Normally rain falls heavily in May or early June to October but actual rainfall in any month varies greatly from year to year.

The average monthly rainfalls at Mt Poppa and other stations are shown in Table 4.2.

Table 4.2 Average rainfalls at stations in central Burma (mm)

Month	Rainfall Station Location[1]			
	Poppa (8)	Meiktila (20)	Nyaung-oo (17)	Myingyan (19)
Jan	4	5	3	4.
Feb	0.	1	0	0.
Mar	3	5.5	4	2.
Apr	15.	28	5	14.
May	152.	145	62	82.
Jun	129.	106	75	84.
Jul	110	72	28	59.
Aug	221	116	71	103.
Sept	210	183	128	145.
Oct	193	165	130	143.
Nov	83	27	19	22.
Dec	1	16	8	9.
Total	1130.	870	533	667.

[1] Figures in brackets represent number of years of record

Rainfall intensities were not measured at Mt Poppa prior to this study.

For the period November until January the temperature varies between $13^{o}C$ and $28^{o}C$. After January temperatures increase until in April the minimum and maximum are about $24^{o}C$ and $40^{o}C$ respectively. Temperatures then fall slightly and in July the range is about $21^{o}C$-$37^{o}C$.

4.2.2.3 Topography

The general configuration of the Kyetmauk-taung catchment is sloping from north to south starting from the summit of Mt Poppa, an isolated hill of nearly 1520 metres(5000 feet). The tributaries of the Kyauk-pon start from the eastern aspect of Mt Poppa whereas those of the Taung-zin start from the western aspect.

The study sites are between the two streams right on the southern aspect of Mt Poppa.

4.2.2.4 Soils

The geological formation of Mt Poppa and the immediate vicinity was described in the working plans (unpublished) for the Meiktila forest division of the Forests Department.

In Burma the tertiary formations are divisible into the Irrawadian and the Pegu series, which are usually unconformable to one another. However in the study area there is seldom a distinct boundary between the two series and the Irrawaddian series usually merges more or less imperceptibly into the underlying Pegus.

The Irrawaddian series is characterized by its highly arenaceous nature. The predominating rock is a somewhat coarse, fawn coloured false-bedded sandstone. Shales occur only locally and usually as tenticles.

Grits with quartz pebbles up to two centimetres in diameter are not uncommon and fossil wood is abundant.

The Pegu series consists of an alternating series of sandstones and shales with the sandstones predominant. They are usually tougher and more compact than those of the Irrawaddian series. They often contain thin calcareous bands and are less falsely-bedded than the Irrawaddians. In isolated localities marine fossils occur in the Pegus. The Pegu shales vary greatly both in colour and texture, ranging from fawn to steel-grey in colour and from fine aluminous to coarse arenaceous clays in texture and composition.

In structure the tertiary area is a succession of anticlines and synclines. Volcanic rocks of tertiary and post-tertiary age are represented by the extinct crater cone of Mt Poppa and its immediate neighbourhood. The rocks are trachytes, volcanic ashes and brecias, and augite and hornblende andesites. The volcanic rocks extend south or southeast for about sixteen kilometres. The volcanic rocks of Mt Poppa yield a dark or brownish red soil which is extremely fertile.

4.2.2.5 Vegetation

The variation in the forest types in the catchment corresponds almost without exception with the variation in the climate with increased elevation. It consists mainly of three forest types, mixed deciduous, plantations and scrub Indaing forests.

The mixed deciduous forests are common in the hills. The principal species are listed in Appendix 4.1. Mt Poppa is an exceptional area for the greater elevation and volcanic soil lead to a special type of the mixed deciduous forest in which teak (*Tectona grandis*), peinne (*Artocarpus integra*), and taung-bein (*Artocarpus calophylla*) occur.

The plantations established in connection with the reafforestation consist mainly of river red gum (*E. camaldulensis*) and (*E. grandis*) with some local species namely,Thitkadoe (*Cedrela toona*), Yinma (*Chukrasia tabularis*), Pyinkadoe (*Xylia dolarbriformis*) Pèinne (*Arthocarpus integra*) and Taung-peinne (*Artocarpus chaplasha*).

Scrub Indaing forest covers the lower ridges of Mt Poppa. The following species occur, stunted in (*Dipterocarpus tuberculatus*), ingyin (*Pentacme sauvis*), taukkyan (*Terminalia tomentosa*), te (*Diospyros burmanica*) and zibyu (*Emblica officinalis*), thitsi (*Melanorrhoea* spp) and occasionally pyinkadoe(*Xylia dolabriformis*) and tamalan (*Dalbergia alivera*).

CHAPTER V

FIELD MEASUREMENTS OF INFILTRATION

5.1 INTRODUCTION

The basis for the field measurement of infiltration rates and the selection of the study areas for the investigation of the effects of changes in the management practices for forest land on infiltration rates were presented in Chapters III and IV respectively.

The apparatus, actual field procedures and the results of the calculations of infiltration rates based on the field measurements are presented in the following sections.

5.2 FIELD MEASUREMENTS

5.2.1 Equipment

The field equipment is shown in Plate 5.1, taken at the field sites in the Kyetmauk-taung catchment. It comprises

(a) A metal infiltrometer cylinder

(b) Constant head device

(c) Inclined aluminium scale

(d) Steel ruler

(e) Protractor head level

(f) Stop watch

(g) Water container

(h) Pickaxe

(i) Shovel

(j) Driving hammer

(k) Driving plate

(l) Auger

(m) Soil moisture cans

(n) Wire gauze

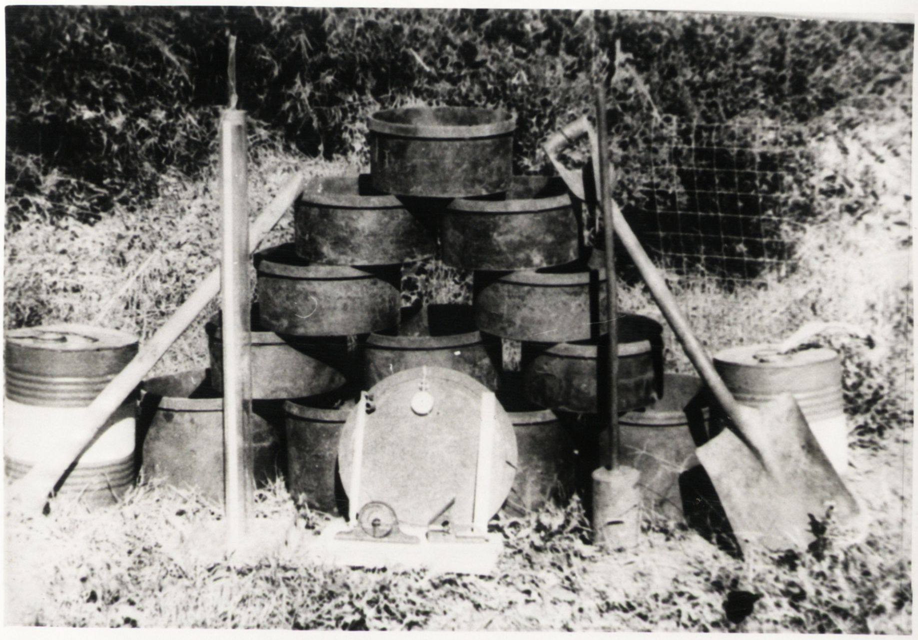


Plate 5.1 Equipment for field measurement of infiltration

The equipment is described in detail in Appendix 5.1.

Following completion of the measurements in the Cotter catchment the equipment was shipped to Burma arriving there after long delays.

The shorter rings (15 cm in height) were used at measurement sites with flat and gentle slopes while the taller rings were used at steeper sites.

5.2.2 Field Procedures

Dr T. Talsma and Mr K. Perroux of the Division of Environmental Mechanics, CSIRO, demonstrated the use of the field equipment while undertaking infiltration measurements at the Honeysuckle Creek Tracking Station. Mr K. Wissopakan, with whom there was joint collaboration in the field measurements, also attended the demonstration.

The procedure at each measurement site was to drive the infiltrometer ring into the soil so that the top of the ring was about 5 cm above the soil surface inside the ring. Plate 5.2 shows a ring being driven at a measurement site in the Kyetmauk-taung catchment. Water was rapidly ponded into the rings to a depth of about 3 cm. The subsequent drop in water level was noted at regular time intervals, from 10 to 15 seconds after ponding, on the inclined aluminium scale graduated at 2 mm intervals over 20 cm, as illustrated in Plate 5.3, a posed photograph with only one observer. One member of the party of two read the scale at an appropriate time and a second observer booked the information which was used to calculate sorptivity as described in the next section.

The scale was suspended from the rim of the infiltrometer ring by adjustable screws, see Plate 5.4. The angle of inclination of the scale can be adjusted and seven degrees was used for convenience. Neither the diameter nor the shape of the ring affects the results.

After taking the readings for the rate at which water enters the soil the rings were left undisturbed overnight. The next day they were removed from the ground and the extracted undisturbed sample was used to measure hydraulic conductivities using the constant head permeater.

The undisturbed sample in the ring was trimmed at the bottom, placed on permeable paper on the wire gauze and levelled and filled with water.

Plate 5.2 Driving an infiltration ring Kyetmauk-taung catchment Burma

Plate 5.3 Reading drop in water level after ponding in the infiltration ring

Plate 5.4 Measurement scale suspended in ring

The wire gauze and paper retained the grains of soil but allowed the passage of water. The constant head device, with the 5 cm tube filled with water while upside down, was turned over and placed over the sample. The stopwatch was started as a small stopper, at the top of the 1.5 cm diameter bubble tube, was removed to allow water to flow through the sample under constant head. Readings on a scale graduated in mm on the 5 mm tube were then taken at 1 minute intervals. One member of the field party of two booked the readings called by the observer using the stopwatch and reading the scale. The procedure is illustrated in Plate 5.5, a posed photograph with only one observer.

The measurements were used to calculate hydraulic conductivity as shown in the next section.

Plate 5.5 Reading the constant head device

It is necessary to take care in driving the infiltrometer ring to reduce disturbance to the soil. The hammer should not be raised to such a height as to cause vibration of the cylinder. On some occasions obstructions were encountered that prevented penetration with the infiltration ring. On these occasions the ring was shifted a few metres and driving recommenced. While such shifts would of course influence the measurements and possibly the average result the main purpose of the study was to examine the effects of land use changes near the surface and it is implicit in the decision to recommence driving of the ring that the obstructions encountered (mainly large stones beneath the surface) would not have been affected by the change in the ground cover. There had been no site preparation such as deep ripping at the study sites.

As noted in the acknowledgements the field measurements undertaken for this study in the Cotter catchment were made with Kamol Wissopakan who was in turn assisted by the author with infiltration measurements in forested areas in the Orroral Representative Basin, Australian Capital Territory. In reporting that work Wissopakan (1977) discussed the field measurement procedures as summarized in Appendix 5.2.

5.2.3 Calculation of sorptivity and hydraulic conductivity

An example of the data collected at each measurement site is shown in Table 5.1.

Table 5.1 Field readings for sorptivity and conductivity

Site 2
Plot A
Sample No.1
Date 2.5.75

SORPTIVITY			CONDUCTIVITY	
Time (mins)	√Time	Reading Scale 1)	Time (mins)	Reading scale (cm) 2)
0	0.0	0	0	0
0.25	0.5	0.9	1	16.5
0.50	0.71	1.6	2	34.0
0.75	0.87	2.2	3	51.0
1.0	1.00	2.9	4	67.5
1.5	1.23	4.0	5	84.5
2.0	1.41	5.2	6	
3.0	1.73	7.4	7	
4.0	2.00		8	
5.0	2.24		9	
6.0	2.45		10	

1) Average height of water = 3.5 cm. Each division = 2 mm.

2) Depth of soil 9.8 cm

Sorptivity values were calculated from the linear portions of initial flow against the square root of time. The procedure followed Talsma (1969) as discussed in Chapter III, pages 19 and 20. An example of the calculation of sorptivity is shown for the measurements given in Table 5.1 in Figure 5.1.

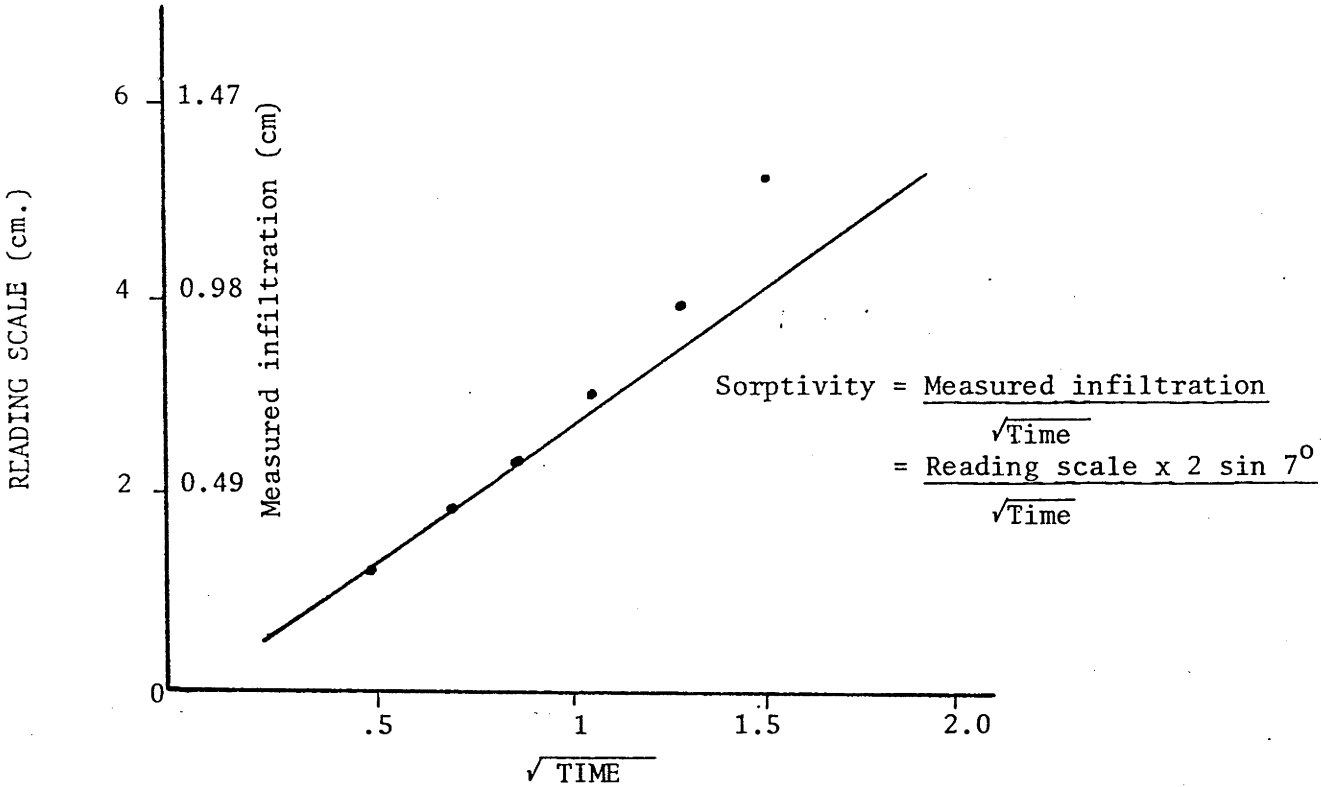


Figure 5.1 Calculation of sorptivity

The hydraulic conductivity was calculated by a direct application of Darcy's law

$$V = K \times \frac{H}{L} \tag{5.1}$$

where V is the velocity of water flow through the soil

K is the hydraulic conductivity

H is the difference in head between two points separated by the distance L.

The volume of water flowing past a section in unit time would be the velocity from Darcy's law multiplied by the cross-sectional area. Table 5.2 shows as an example the conversion of the field measurements shown in Table 5.1 to the volume of water flowing through the soil sample under a constant head. The calculation of the hydraulic conductivity is shown below Table 5.2.

After calculation of sorptivity and hydraulic conductivity the infiltration rate was calculated using the formula

$$V = \tfrac{1}{2} S t^{-\frac{1}{2}} + \frac{K}{2.8} \qquad (5.2)$$

The total infiltration up to a designated time was calculated using the formula

$$i = S t^{\frac{1}{2}} + \frac{Kt}{2.8} \qquad (5.3)$$

Table 5.2 Calculation of hydraulic conductivity

Time (mins)	Scale reading (cm)	Volume infiltration (cm^3)		Volume per minute (cm^3)
0	0			
1	16.5	306		306
2	34.0	630		315
3	51.0	945		315
4	67.5	1250		316
5	84.5	1570		323
			Total	1575

Average rate of water infiltrated = 315
Cross-sectional area of the infiltrometer ring = 707 cm^2
Measured depth of soil in the ring (L in equation 5.1) = 9.8
Measured height of water in the ring[1] = 13.3
(H in Equation 5.1)

Thus from Equation 5.1
Hydraulic conductivity $= V \times \frac{L}{H}$

$$= \frac{315}{707} \times \frac{9.8}{13.3}$$

$$= 0.33 \quad cm\ sec^{-1}$$

1) The height of water from the bottom of the ring to the lower part of the perspex sheet and equals height of ring less 1.7 cm, the thickness of the perspex base plate

5.3 SAMPLING PROCEDURES AND RESULTS FOR INFILTRATION MEASUREMENTS AT THE COTTER CATCHMENT STUDY SITES

5.3.1 Introduction

As discussed in Chapter II Sein Thet (1975) had investigated the effects of forest management on soil erodibility in the Pierce's Creek Forest in the lower Cotter catchment. The following sites were investigated by Sein Thet.

(1) Natural dry sclerophyll forests on granite and shale soils

a. upslope of a gravity pipeline installed underground through the forest

b. downslope of the gravity pipeline track.

(2) Pine plantations on granite and shale soils

a. upslope of the gravity pipeline track

b. downslope of the gravity pipeline track.

(3) Along the gravity pipeline track

a. on granite soil

b. on shale soil

Similar sites were selected for this study.

Seven sections were selected along the gravity pipeline and seventeen plots were set out each 10 metres by 2 metres. The plots are shown in Figure 5.2.

The notations for the sites and the soil types, vegetation and positions with respect to the pipeline are given in Table 5.3.

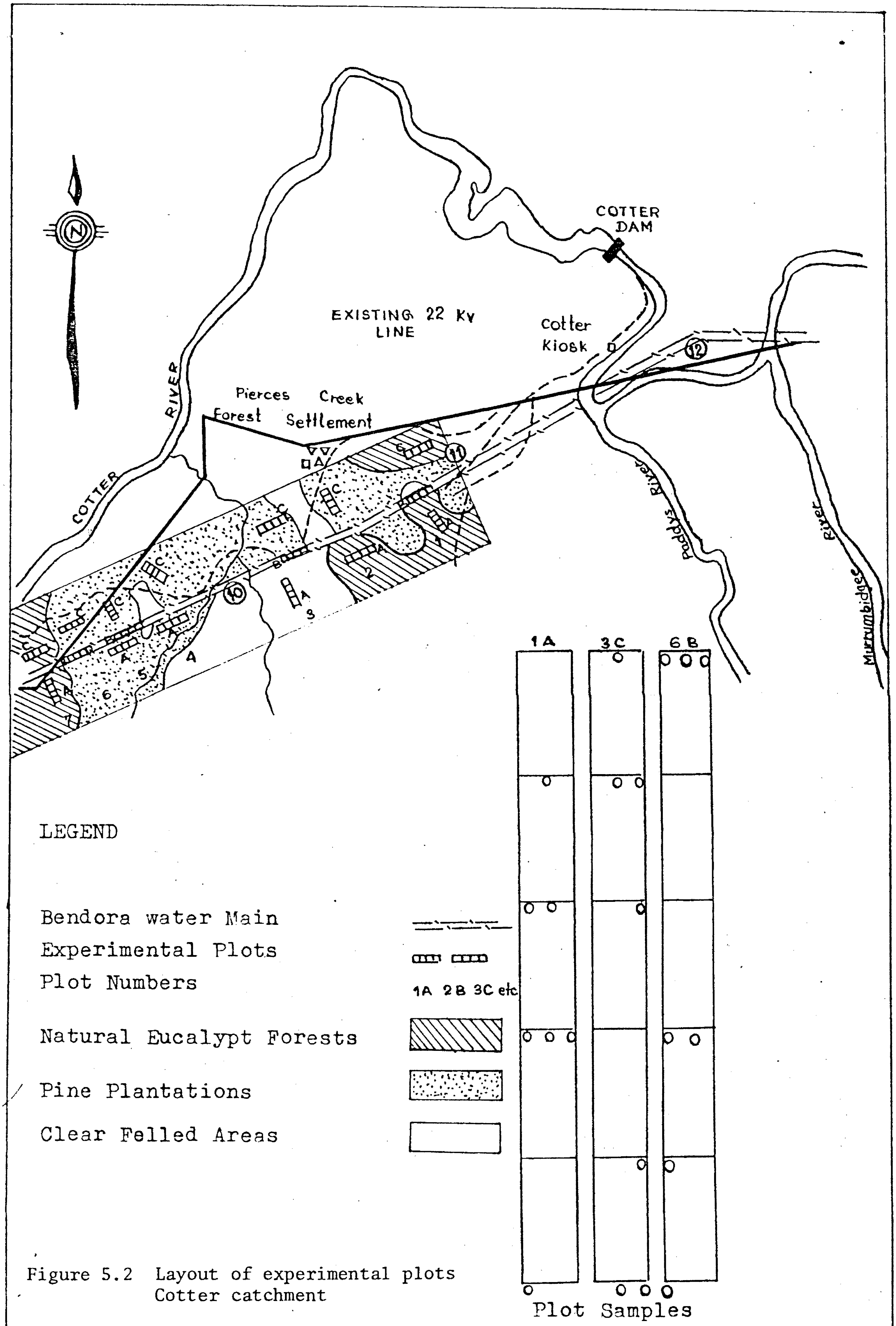


Figure 5.2 Layout of experimental plots
Cotter catchment

Table 5.3 Plot notations and characteristics - Pierce's Creek

Site No.	Soil type	Vegetation	Location from gravity main	Notation
1A	Granite	eucalypts	Up	1A, GE
B	"	grass	G. main	1B, G-G Main
C	"	eucalypts	down	1C, GE
2A	"	"	up	2A, GE
C	"	pine	down	2C, GP
3A	"	pine (clear-fell)	up	3A, GP(clear)
B	"	grass	G.main	3B, G.G.Main
C	"	pine	down	3C, GP
4A	"	pine	up	4A, GP
C	"	pine	down	4C, GP
5A	Shale	pine	up	5A, SP
B	"	grass	G.main	5B, S.G.Main
C	"	pine	down	5C, SP
6B	"	grass	G.main	6B, S.G.Main
C	"	pine	down	6C, SP
7A	"	eucalypts	up	7A, SE
C	"	"	down	7C, SE

(after Sein Thet, 1975)

The sites and plots are classified according to soil type and vegetation in Table 5.4.

Table 5.4 Classification of sample plots - Pierce's Creek

Soil type and vegetation	Position from Gravity Main	Site and Plot number
G.E.	Up	1A, 2A
G.E.	Down	1C
G. grass	G. Main	1B, 3B
G.P.	Up	4A
G.P.	Down	2C, 3C, 4C
G.P (clear)	Up	3A
S.E.	Up	7A
S.E.	Down	7C
S.P.	Up	5A
S. grass	G.main	5B, 6B
S.P.	down	5C, 6C

(After Sein Thet, 1975)

The subsequent analysis of the results for the infiltration rates at the sites indicated that the position on the slope significantly affected the infiltration rates and further investigations of the effect of position on the slope were therefore undertaken in connection with the study. For convenience, the details of the sites selected are presented below.

5.3.1.1 Sites in the Uriarra Forest

A relatively long slope with uniform vegetation and soil type was defined as the requirement for the site to examine infiltration characteristics with respect to position, that is elevation, on the slope.

A good uniform stand of thirty nine year old *Pinus radiata* plantation in Compartment 62 in the Uriarra Forest was selected. It had a slope length of between 400 and 500 metres and a slope ranging between 12^{o} and 18^{o}. The soil was of a granite base weathered into a deep forest soil with a thick layer of litter on the ground.

Three sites on the slope were selected, at the top, the middle and the bottom. Two plots were located at each site. The location of the plots is shown diagrammatically in Figure 5.3 prepared from a compartment map of Uriarra Forest. The soil type and slope for each plot is shown in Table 5.5.

Table 5.5 Plots in Uriarra area

Site and plot No.	Soil type	Slope position
1		
A1	Granite forest soils	top
A2	" " "	"
2		
B1	" " "	middle
B2	" " "	"
3		
C1	" " "	bottom
C2	" " "	"

5.3.2 Sampling methods

A randomized block design was adopted to design the sampling. At each of the 10 m x 2 m plots seven out of a possible eighteen positions were selected using a series of random numbers (Hoel, 1971), the eighteen positions corresponding to a corner of a 1 metre square. The randomly selected ring numbers in each plot are shown in Table 5.6.

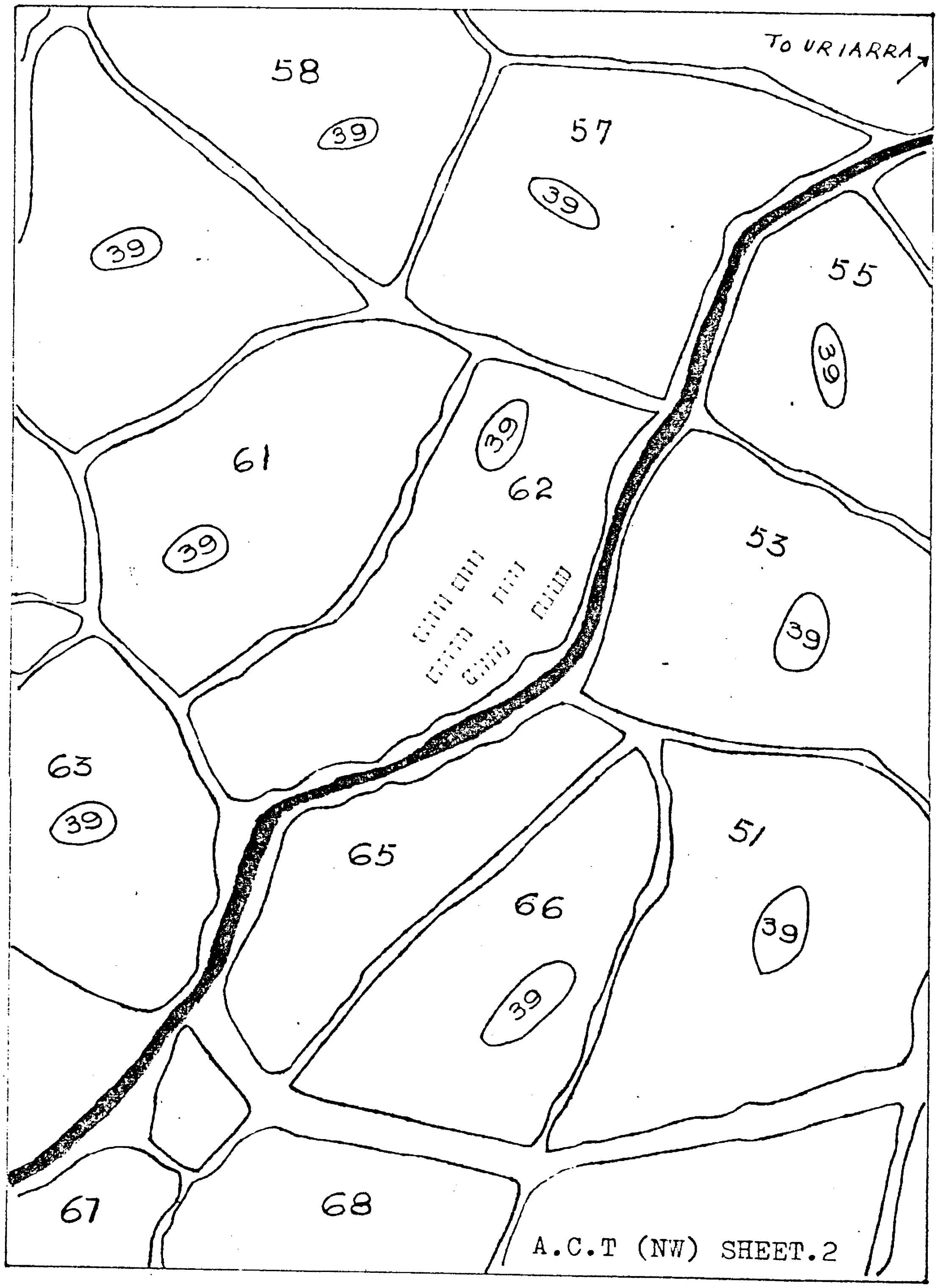


Figure 5.3 Experimental sites in Uriarra Forest

39 - PINE PLANTATIONS ESTABLISHED IN 1939

62 - COMPARTMENT NUMBERS

\- MAIN ROAD

\- EXPERIMENTAL PLOTS

Table 5.6 Random location of measurement rings

Area	Site and plots	Location (random ring numbers)						
PIERCE'S CREEK								
	1A	5	7	8	10	11	12	16
	1B	1	5	9	10	11	16	18
	1C	3	6	8	13	15	16	17
	2A	6	7	9	10	11	15	16
	2C	2	4	6	9	12	16	18
	3A	2	3	4	6	11	14	16
	3B	1	6	8	9	10	11	17
	3C	2	5	6	9	15	17	18
	4A	3	4	9	12	14	15	16
	4C	1	2	3	5	8	15	18
	5A	3	4	7	8	10	17	18
	5B	1	2	3	5	8	15	17
	5C	1	3	5	6	11	14	15
	6B	1	2	3	10	11	13	16
	6C	1	5	7	8	11	16	17
	7A	1	2	5	6	8	10	12
	7C	2	5	10	11	13	16	18
URIARRA PINE SLOPE								
	A_1	4	5	6	8	10	11	16
	A_2	7	8	10	11	12	13	18
	B_1	2	6	9	11	15	16	18
	B_2	4	6	7	10	12	16	18
	C_1	2	3	5	6	8	9	10
	C_2	1	2	3	9	11	14	15

5.3.3 Results

5.3.3.1 Pierce's Creek

The calculated values of sorptivity, hydraulic conductivity, the cumulative infiltration after one minute and the infiltration rate at one minute together with the gravimetric moisture content taken at each site are shown in Appendix 5.3.

The cumulative infiltration at 1,6,12,18,30,60,120,180,360,720,1440, 2880 and 4320 minutes are shown in Appendix 5.4.

The infiltration rates at 1,6,12,18,30,60,120,180,360,720,1440,2880 and 4320 minutes are shown in Appendix 5.5.

It should be noted that Appendices 5.4 and 5.5 are computer printouts and that the predicted infiltration and infiltration rates are only valid for infiltration into about 10 cm of soil. Thus for the longer time periods infiltration values may be determined by the sorptivities of the deeper layers of the soil profile.

The calculated values of sorptivity for the sites within both the eucalypt forests and the pine plantations are shown in Figures 5.4 and 5.5 respectively.

The calculated values of hydraulic conductivity for the sites within both the eucalypt forests and the pine plantations are shown in Figures 5.6 and 5.7 respectively.

The calculated values of the total infiltration after 1 minute for the sites within both the eucalypt forests and the pine plantations are shown in Figures 5.8 and 5.9 respectively.

5.3.3.2 Uriarra

The calculated values of sorptivity, hydraulic conductivity, the cumulative infiltration after 1 minute and the infiltration rate at

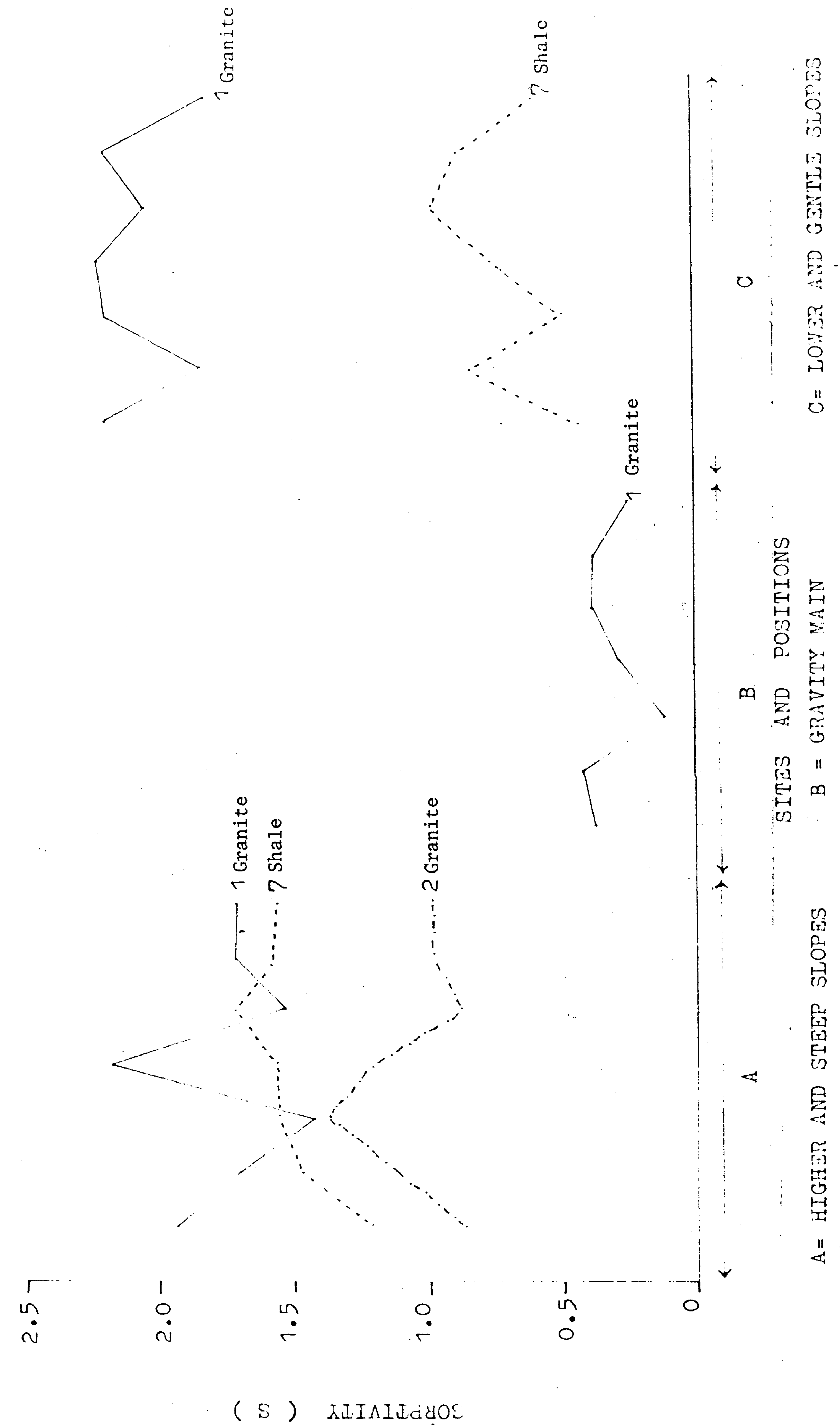


Figure 5.4 Sorptivities in eucalypt sites

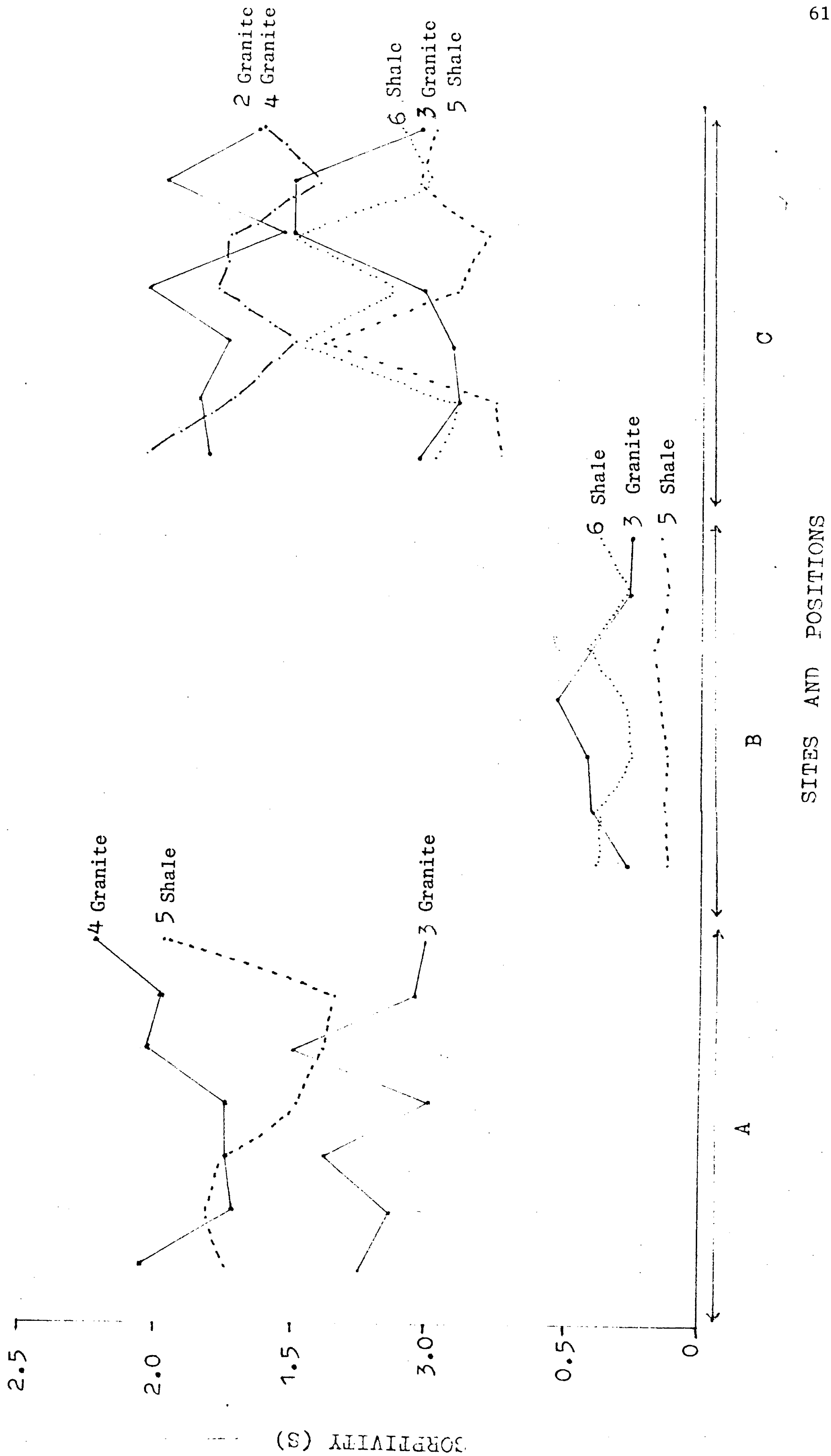
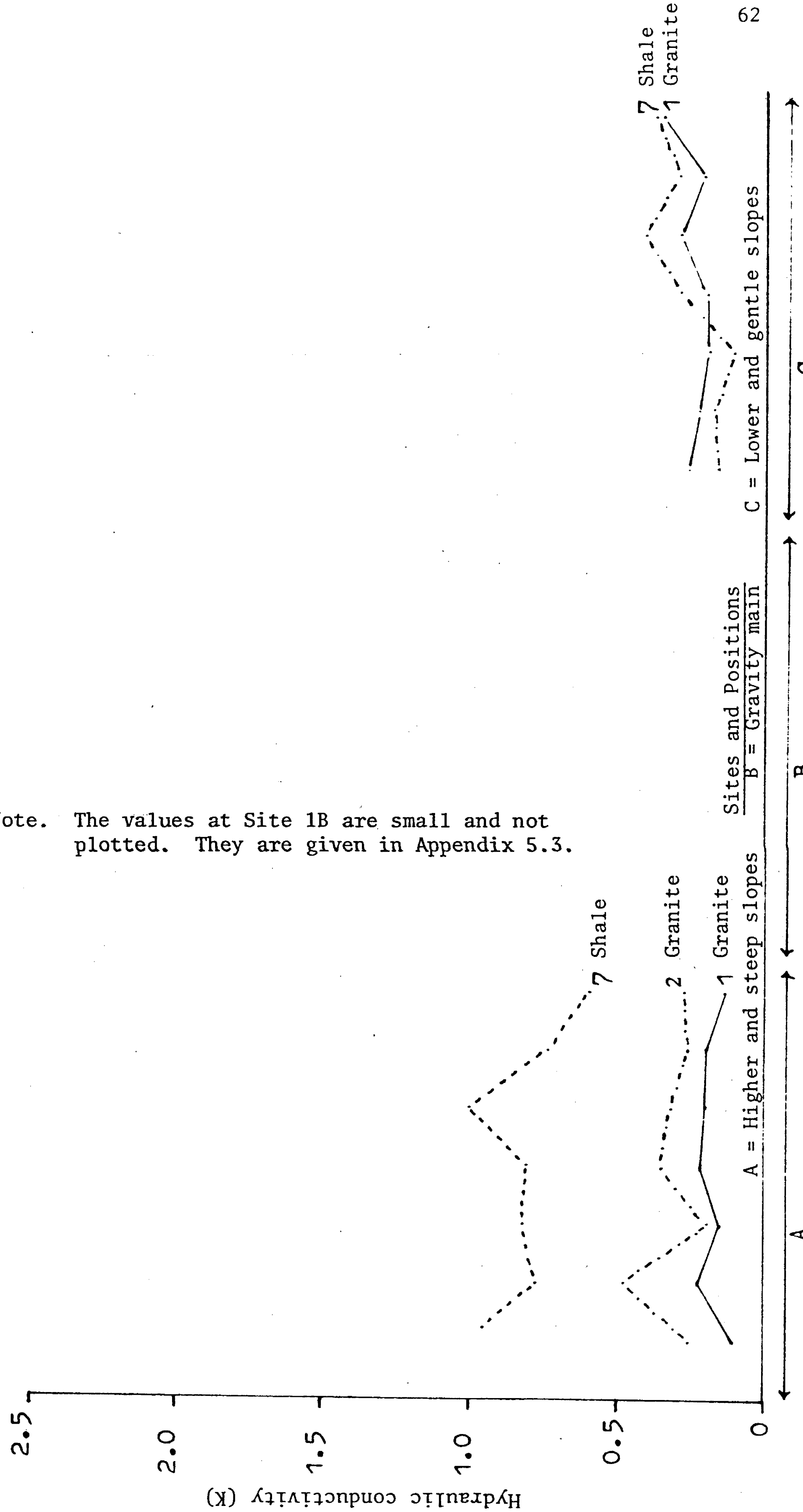
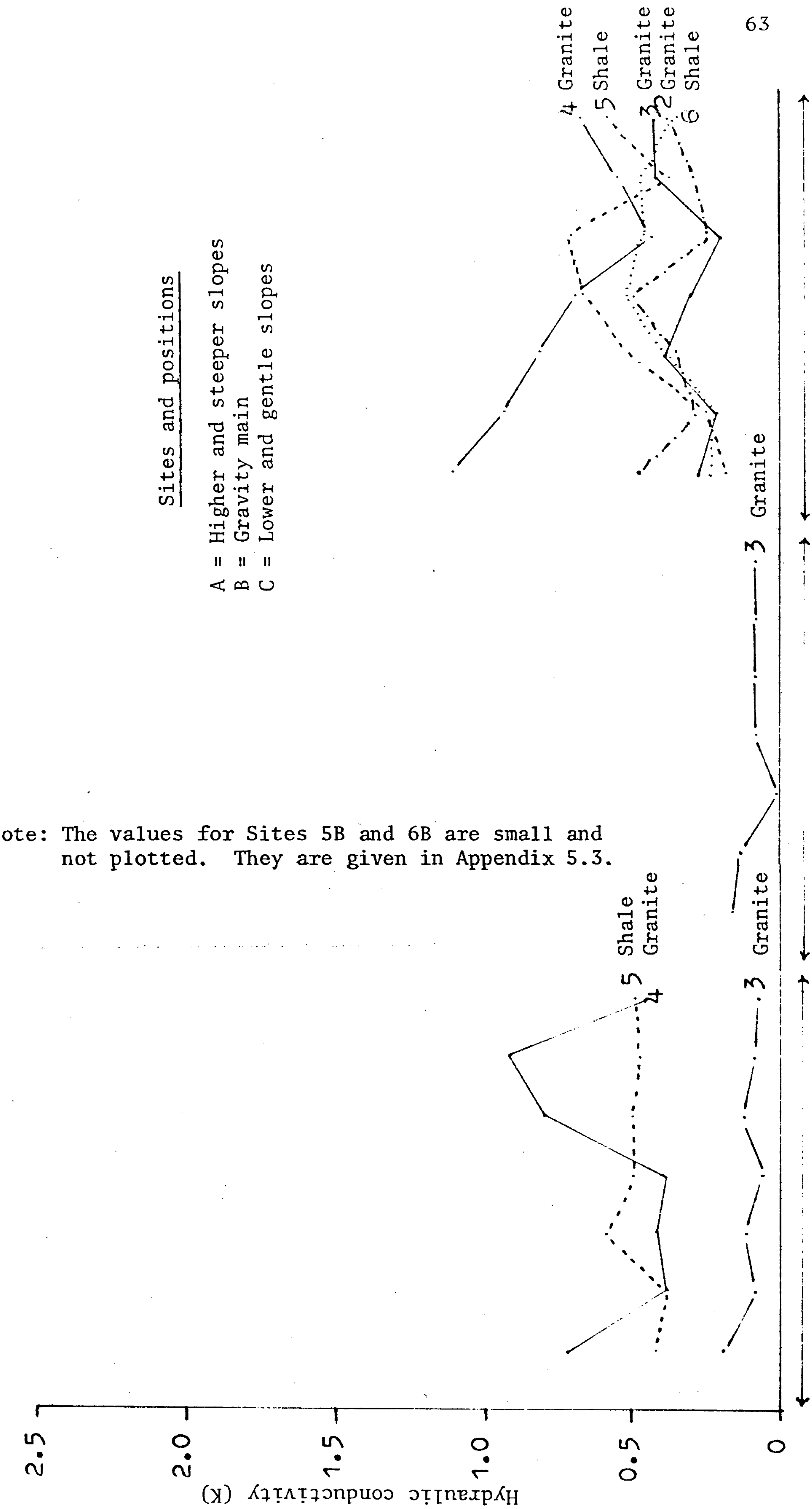


Figure 5.5 Sorptivities in pine plantation sites



Note. The values at Site 1B are small and not plotted. They are given in Appendix 5.3.

Figure 5.6 Hydraulic conductivities in eucalypt sites



Note: The values for Sites 5B and 6B are small and not plotted. They are given in Appendix 5.3.

Figure 5.7 Hydraulic conductivities in pine plantation sites

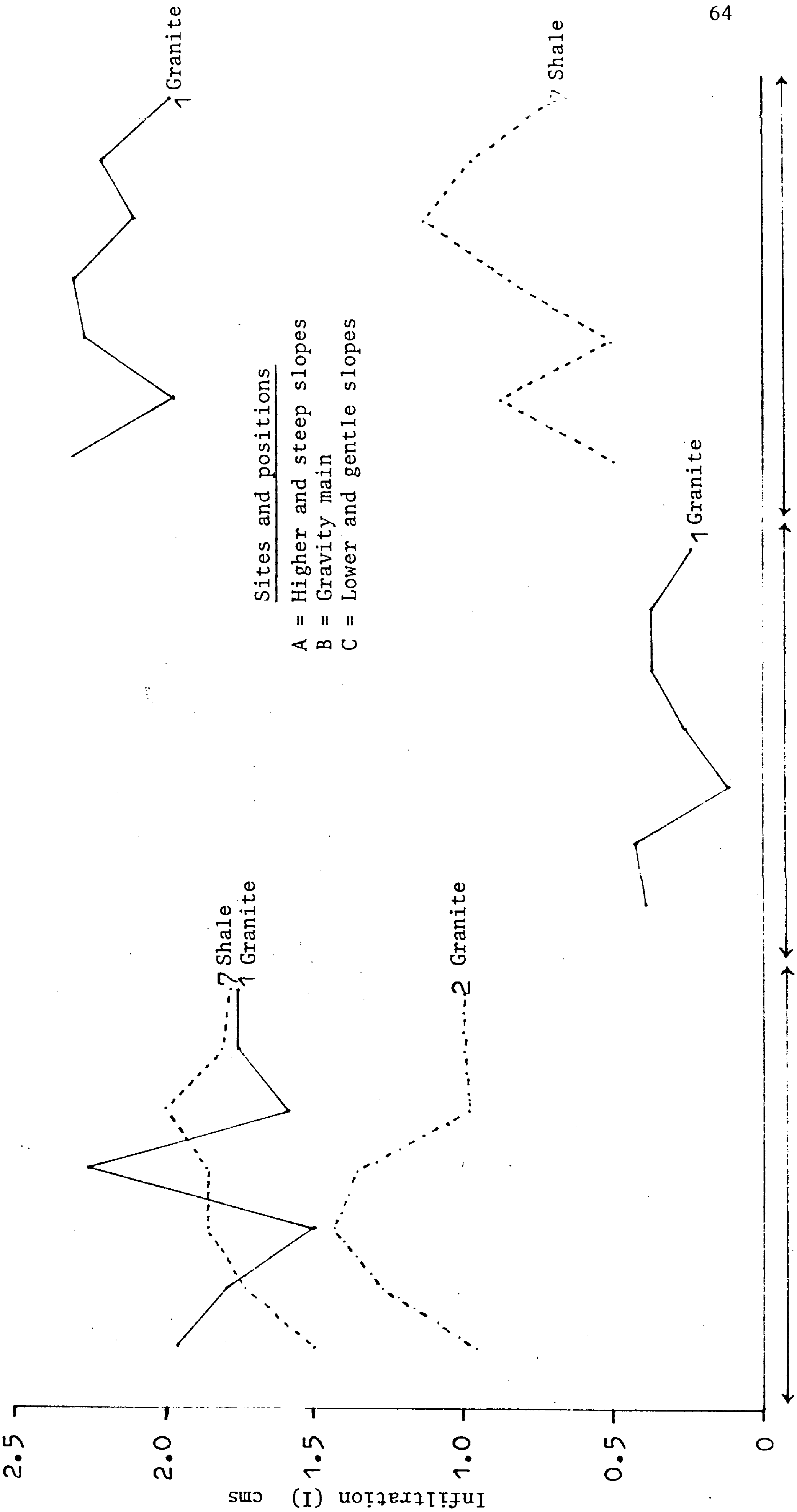


Figure 5.8 Cumulative infiltration after 1 minute in eucalypt sites

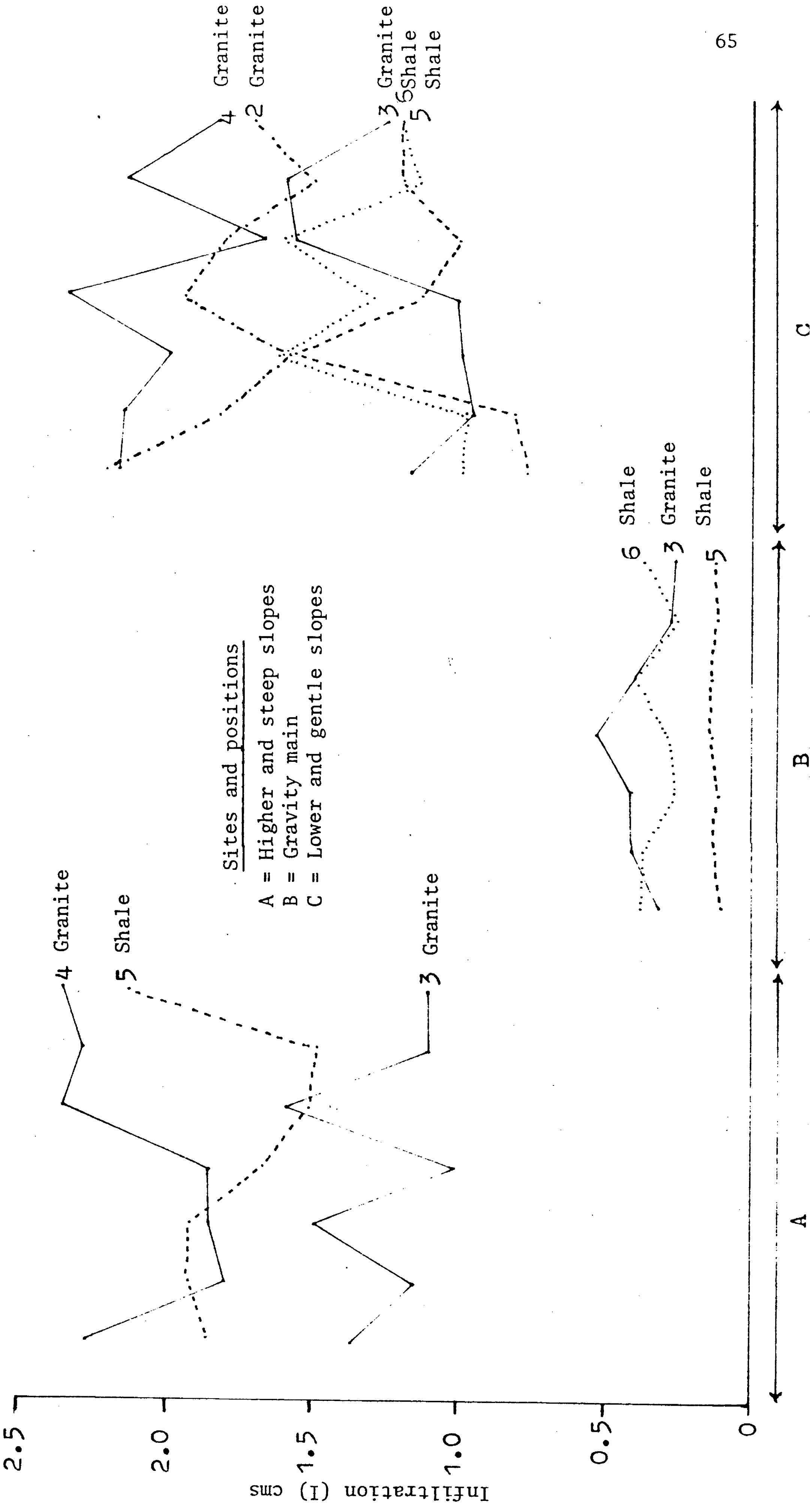


Figure 5.9 Cumulative infiltration after 1 minute in pine plantation sites

1 minute together with the gravimetric moisture content taken at each site are shown in Appendix 5.6.

5.3.4 Analysis and statement of results

5.3.4.1 Pierce's Creek

(a) The installation of the underground gravity pipeline involved the removal of considerable depths of soil in providing the pipeline bench, see for example Plates 4.1 and 4.6.

The lower values of sorptivity, hydraulic conductivity and hence cumulative infiltration after 1 minute at the sites on the gravity main, as illustrated in Figures 5.4 to 5.9 inclusive, indicate as would be expected decreasing infiltration rates with increasing depths from the soil surface.

(b) There is very considerable variability in the values of the measured parameters, namely sorptivity and hydraulic conductivity, within the 10 metre x 2 metre plots. For example,

(1) the sorptivity values at site 1 on granite soils in the eucalypt forest as illustrated in Figure 5.4,

(2) the sorptivity values at site 5 on shale soils in the pine plantation as illustrated in Figure 5.5.,

(3) the hydraulic conductivity on shale soils in the eucalypt forest as illustrated in Figure 5.6,

(4) the hydraulic conductivity on granite soils in the pine plantation as illustrated in Figure 5.7.

(c) There is also very considerable variability in the measured values of the sorptivities and hydraulic conductivities between sites in the same soil and vegetation type. For example,

(1) the sorptivities at sites 1 and 2 in granite soils on the upper slopes of eucalypt forest as illustrated in Figure 5.4,

(2) the sorptivities at sites 4 and 3 in granite soils on the upper slopes of plantations as illustrated in Figure 5.5.,

(3) the sorptivities at site 7 in shale soils on the upper and lower slopes of eucalypt forest as illustrated in Figure 5.4.,

(4) the sorptivities at sites 6 and 5 in shale soils on the lower slopes of pine plantations as illustrated in Figure 5.5.

(d) Statistical tests indicated significant differences between measured values of the parameters within the same classification, for example sorptivities of granite soils on the upper slopes of eucalypt forest (Figure 5.4) and on the upper slopes of pine plantations (Figure 5.5). It is not therefore permissible to pool the values obtained from plots within the same classification of soil type, vegetation type and position with respect to the gravity main.

(e) There is some indication that the position on the slope affects the values of the measured parameters. For example,

(1) sorptivities at site 7 in shale soils in eucalypt forest as illustrated in Figure 5.4,

(2) sorptivities at site 4 in granite soils in pine plantations as illustrated in Figure 5.5.

(f) As stated above there are significant differences between measured values of the parameters within the same classification and it is not permissible to pool the values obtained from plots for statistical tests. However pooling of the data and statistical testing as shown in Appendix 5.7 again suggested that position in the slope had significant effects. Further field measurements were therefore undertaken in the

Uriarra Forest to examine for position on the slope. These sites were described in Section 5.3.1.1, page 55.

5.3.4.2 Uriarra Forest

The results of the statistical tests for the analysis of the measurements for sorptivity are shown in Table 5.7.

Table 5.7 Test of significance (t test) on sorptivity (S)
Compt. 62 Uriarra Forest pine plantation 12.8 ha
Slope - >12° <20° eastern aspect

Blocks on					Significant level	
top of the slope	Middle of the slope	bottom of the slope	df	t	.5	.001
A_1 & A_2			12	4.5553		sig.
A_1 & A_2	B_1 & B_2		26	-7.6035		sig.
	B_1 & B_2		12	1.1937	Not sig.	
	B_1 & B_2	C_1 & C_2	26	7.0872		sig.
A_1 & A_2		C_1 & C_2	26	-0.7672	Not sig.	
		C_1 & C_2	12	4.4443		sig.

The results in Table 5.7 of the statistical tests show significant differences between the sorptivities measured in different plots at the same sites, namely A_1 and A_2 at the top of the selected slope and C_1 and C_2 at the bottom of the slope. They also show that there was no significant difference between the sorptivities at plots B_1 and B_2 at the middle of the slope.

Thus the pooling of the data as was done for some of the statistical tests associated with Table 5.7 is not valid and while the pooled data suggest significant differences with respect to position on the slope, for example between (A_1 and A_2) and (B_1 and B_2) and between (B_1 and B_2) and (C_1 and C_2) it cannot be concluded from the tests that position on the slope significantly affects sorptivities.

The mean values of the sorptivities measured on the upper, mid and lower slopes are shown below.

Top of slope	1.23
Middle of slope	1.89
Bottom of slope	1.30

The mean value is higher at the middle of the slope than at the top and the bottom of the slope and there is no trend with respect to position on the slope.

5.3.5 Discussion

The range in the predicted values for cumulative infiltration and the infiltration rate within one plot and the result that there are significant differences between plots located on the same soil type, within the same forest type and at the same position on the slope precludes rigorous statistical analysis and suggests that the technique of intensive sampling near the plots originally selected by Sein Thet (1975) was not suitable and that random sampling within an extensive grid would be more appropriate. This procedure was adopted for the studies in Burma.

The range of the results obtained from the field measurements is summarized in Table 5.8 and Figures 5.10 and 5.11. The data has been grouped into the simple classification of high eucalypt forest, low eucalypt forest, high pine forest and low pine forest. In Figure 5.10 the range in cumulative infiltration for periods up to five hours in high eucalypt forest is compared with the values for high pine forest. In Figure 5.11 a similar comparison is made between low eucalypt forest and low pine forest. High and low are with respect to the gravity main.

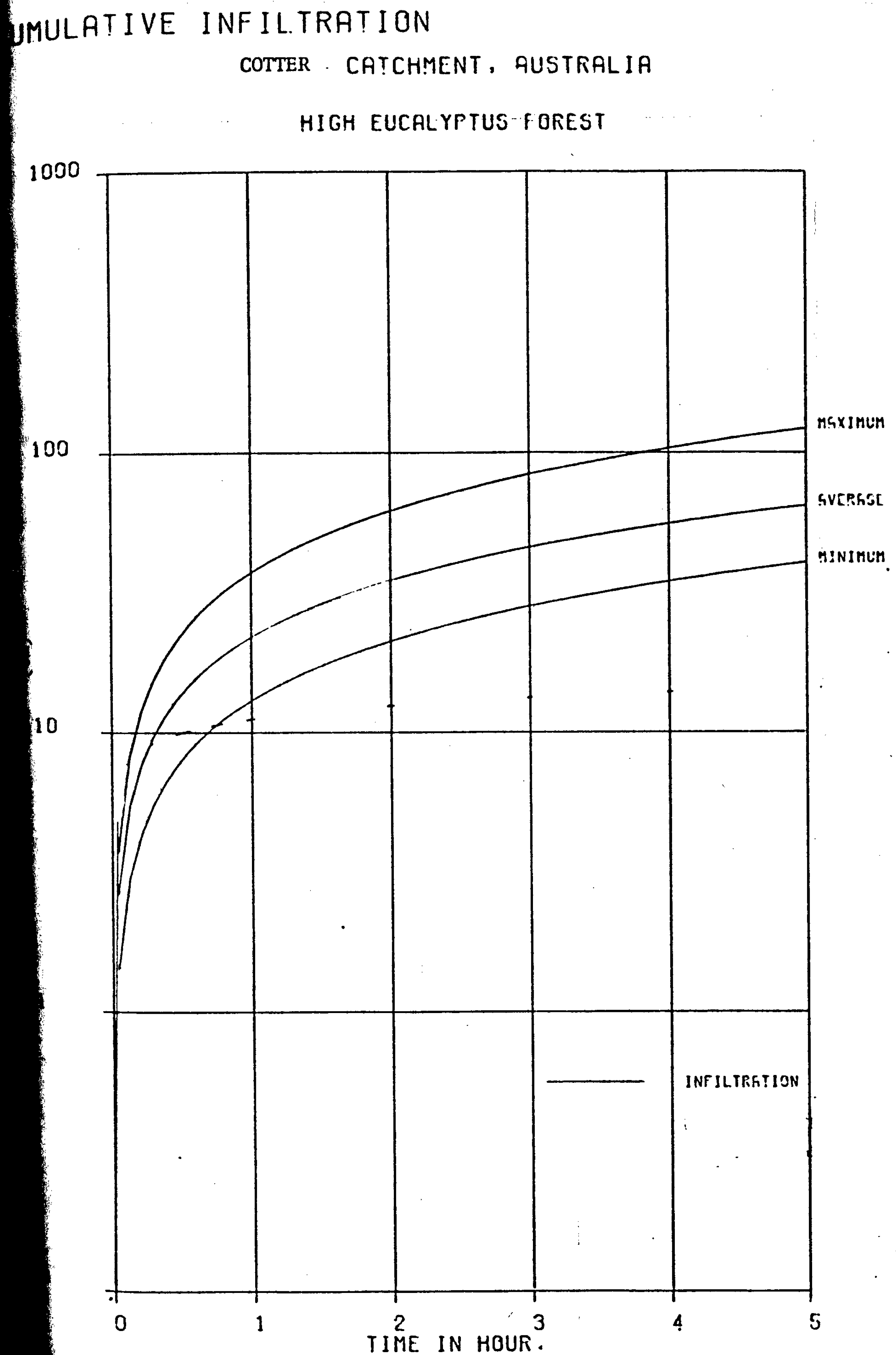
The results presented in Figures 5.10 and 5.11 suggest that there has been no major change in the infiltration characteristics to depths of about ten centimetres at the study area as a consequence of conversion from eucalypt forest to pine plantations.

Table 5.8 Cumulative infiltration for different types of forest in the Cotter catchment area, Australia

Time (min.)	Cumulative infiltration (cm)					
	High *Eucalyptus* (21 samples)			Low *Eucalyptus* (14 samples)		
	Min.	Max.	Mean	Min.	Max.	Mean
1	0.96	2.28	1.60	0.50	2.31	1.48
6	2.70	6.37	4.48	1.45	5.95	3.97
12	4.16	10.29	6.89	2.20	8.76	5.95
18	5.42	13.81	8.96	2.83	11.05	7.61
30	7.64	20.29	12.63	3.94	14.92	10.47
60	12.50	35.11	20.64	6.32	22.80	16.50
120	21.06	62.48	34.74	10.43	35.70	26.73
180	28.98	88.67	47.77	14.17	47.53	35.92
360	47.48	163.71	84.20	24.51	80.88	60.97

Table 5.8 (cont.)

Time (min.)	Cumulative infiltration (cm)					
	High pine (14 samples)			Low pine (35 samples)		
	Min.	Max.	Mean	Min.	Max.	Mean
1	1.49	2.36	1.95	0.79	2.35	1.50
6	4.28	6.78	5.48	2.22	6.79	4.29
12	5.68	10.76	8.44	3.42	11.03	6.68
18	8.76	14.28	10.99	4.45	14.81	8.75
30	12.50	20.69	15.51	6.27	21.90	12.46
60	20.79	35.13	25.39	10.24	38.09	20.66
120	35.60	61.40	42.80	17.21	68.10	35.30
180	48.41	86.23	58.91	88.66	96.79	48.94
360	83.61	157.14	104.00	41.68	179.60	87.43


UMULATIVE INFILTRATION
COTTER CATCHMENT, AUSTRALIA
HIGH EUCALYPTUS FOREST
1000
100
10
MAXIMUM
AVERAGE
MINIMUM
INFILTRATION
0
1
2
3
4
5
TIME IN HOUR.

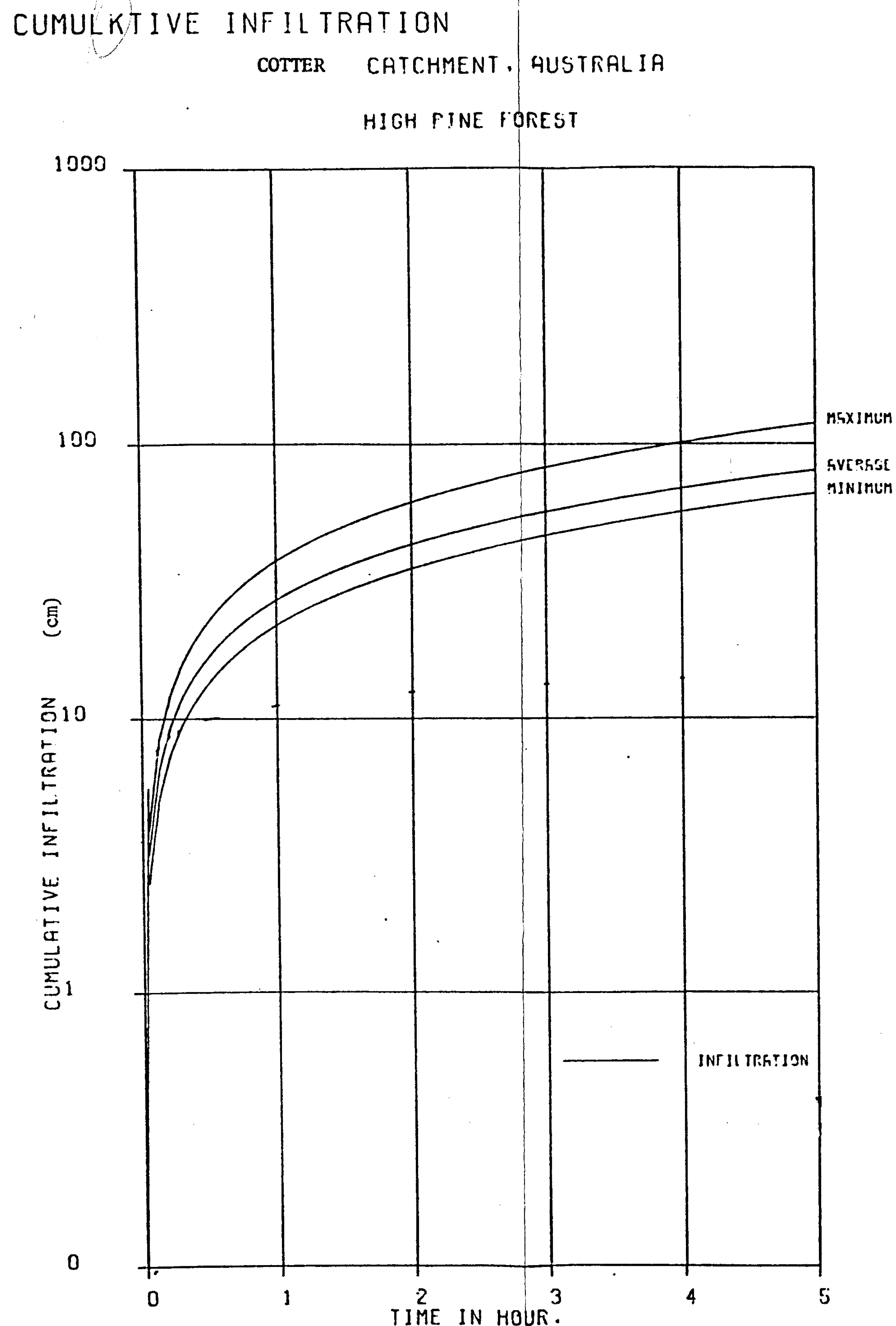
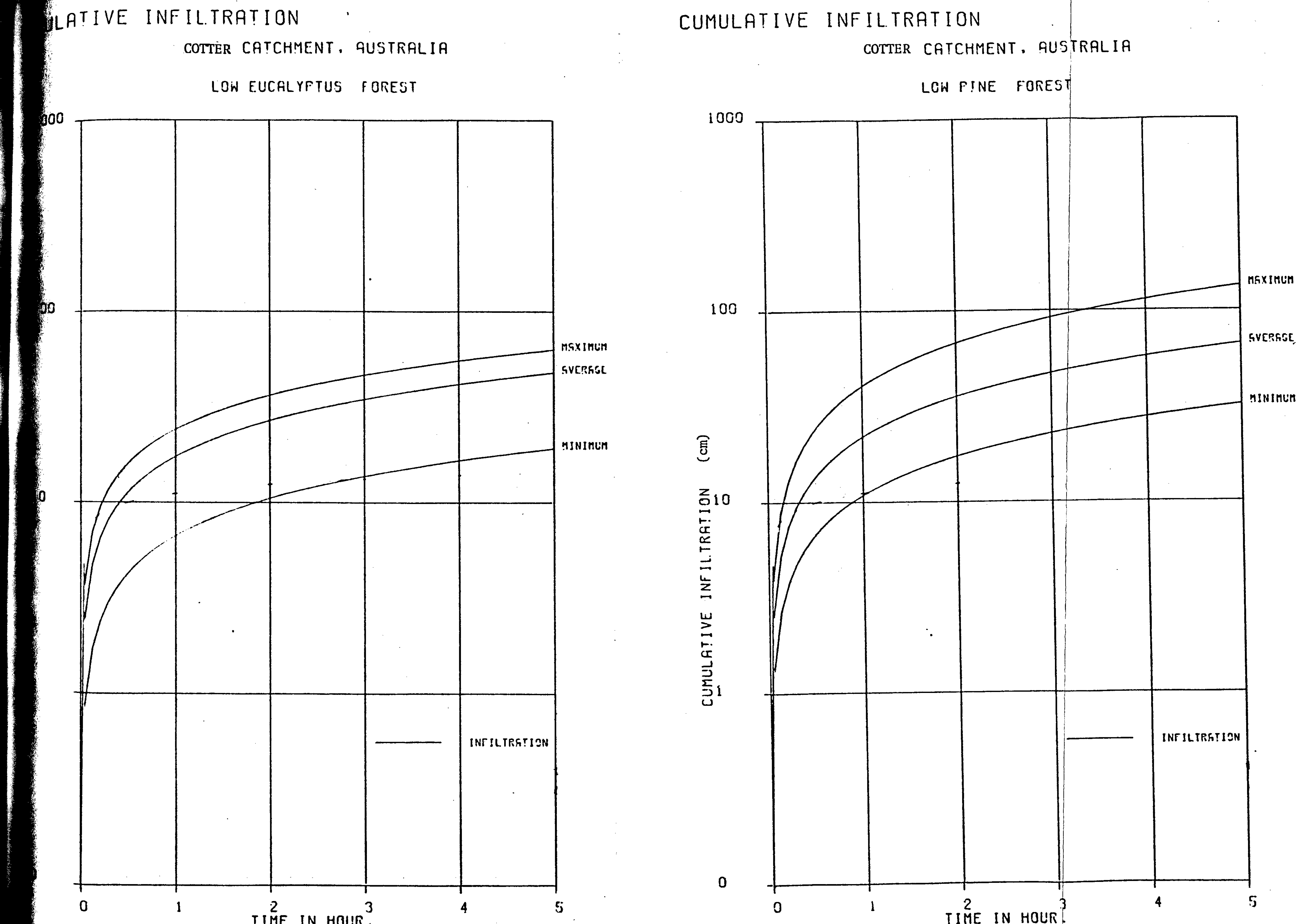

CUMULATIVE INFILTRATION
COTTER CATCHMENT, AUSTRALIA
HIGH PINE FOREST
CUMULATIVE INFILTRATION (cm)
1000
100
10
1
0
MAXIMUM
AVERAGE
MINIMUM
INFILTRATION
0
1
2
3
4
5
TIME IN HOUR.

Figure 5.10



LATIVE INFILTRATION
COTTER CATCHMENT, AUSTRALIA
LOW EUCALYPTUS FOREST
MAXIMUM
AVERAGE
MINIMUM
INFILTRATION
0 1 2 3 4 5
TIME IN HOUR.
CUMULATIVE INFILTRATION
COTTER CATCHMENT, AUSTRALIA
LOW PINE FOREST
1000
100
10
1
0
CUMULATIVE INFILTRATION (cm)
MAXIMUM
AVERAGE
MINIMUM
INFILTRATION
0 1 2 3 4 5
TIME IN HOUR.

Figure 5.11

5.4 SAMPLING PROCEDURES AND RESULTS FOR INFILTRATION MEASUREMENTS AT THE KYETMAUK-TAUNG STUDY SITES

5.4.1 Sampling procedures

A rectangular plot 1.6 x 3.2 kilometres (1 x 2 miles) was laid down on the southern aspect of Mt Poppa in the Kyetmauk-taung catchment so that it covered three different types of forests, namely mixed deciduous forests, plantations (old banana plantations) and semi-indaing forest. The rectangular block was subdivided into four blocks, each of the four blocks containing the three forest types.

The study area is shown on Map 5.1.

A two stage randomised block design was adopted to determine the sampling.

Square plots 0.2 x 0.2 kilometres were laid down in each of the four blocks. A total of 192 square plots were thus demarcated with temporary light blazes.

It was estimated that the feasible maximum number of measurement sites would be 45 in the mixed deciduous forest (A), 44 in plantations (B), and 44 in the semi-indaing (C). Thus 133 square plots were randomly selected. The plots are shown classified in terms of the three forest types and the four blocks in Table 5.9.

Table 5.9 Classification of randomly selected plots, Kyetmauk-taung catchment. Dry season measurements

Forest type	Blocks				Total
	I	II	III	IV	No.
A[1)]	11	14	10	10	45
B[2)]	8	8	14	14	44
C[3)]	13	12	10	9	44
Total	32	34	34	33	133

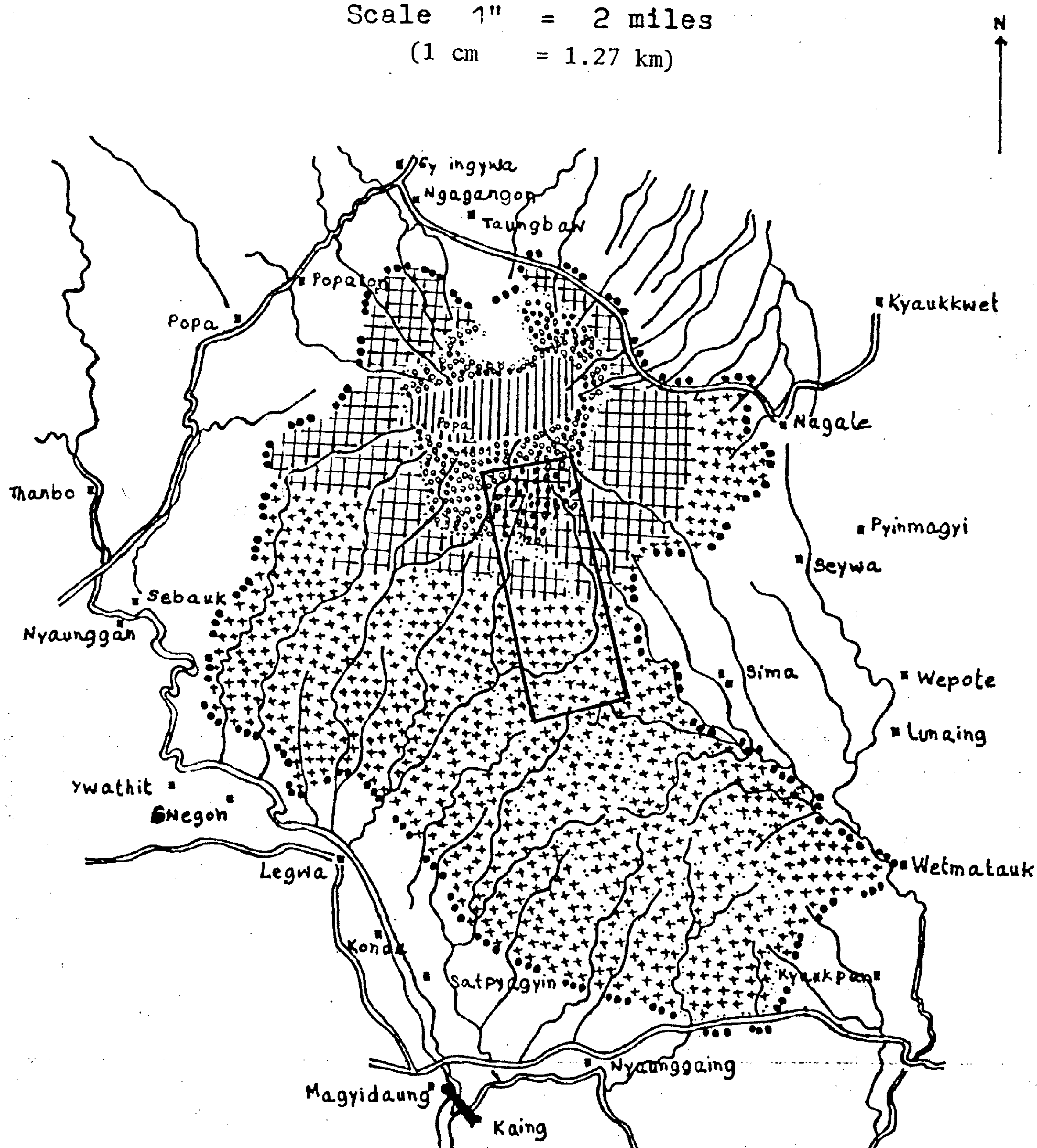
1) A = mixed deciduous forest, 2) B = plantations, 3) = semi-indaing

MAP SHOWING KYETMAUK-TAUNG DAM

CATCHMENT AREA

AT MT. POPPA.

Scale 1" = 2 miles
(1 cm = 1.27 km)



LEGEND

Plantation — Reserved Forest Boundary

Mixed deciduous forest — Proposed Reserve Boundary

Semi-Indaing forest — Roads

Grassland — Kyetmauk-taung Dam

Experimental area — Village

Map 5.1

The layout of the plots is shown diagrammatically in Figure 5.12.

In the first phase of the field measurements infiltration measurements were made in the 133 plots in May 1977 while the moisture content of the soil was quite low.

In the second phase 60 square plots were randomly selected out of the 133 plots. 15 plots were allocated to each block and 20 in each forest type. The second phase sampling was for measurement of infiltration in the wet season. The measurements were taken in October 1977 when the moisture content was high just before the end of the wet season. The plots are shown classified in terms of the three forest types and the four blocks in Table 5.10.

Table 5.10 Classification of randomly selected plots Kyetmauk-Taung catchment. Wet season measurements

Forest type	Blocks I	II	III	IV	Total No.
A	5	5	5	5	20
B	5	5	5	5	20
C	5	5	5	5	20
Total	15	15	15	15	60

The notation for the plots together with information on the soil type and the elevation are shown in Table 5.11.

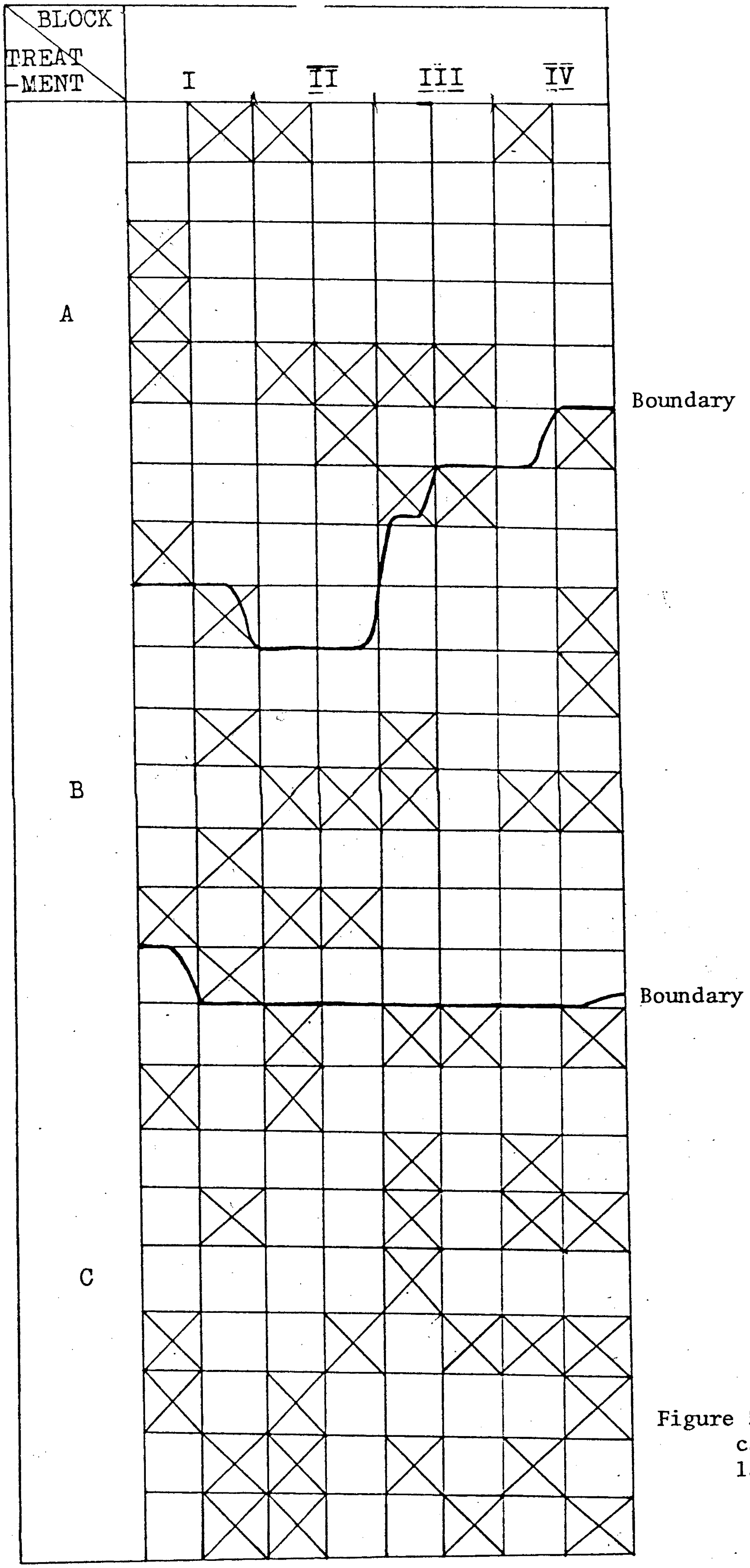


Figure 5.12 Kyetmauk-taung catchment random plot layout diagram

Table 5.11 Notation and plot characteristics Kyetmauk-taung catchment (Wet and dry season measurements)

Plot	Forest cover	Soil type	Elevation a.s.l.	Blocks & sample numbers I	II	III	IV
A	Mixed deciduous forest	Black volcanic ash soil	910 to 1070	Dry-11	14	10	10
				Wet- 5	5	5	5
B	Plantations(old banana plantations)	Brown volcanic ash soil	760 to 1070	Dry- 8	8	14	14
				Wet- 5	5	5	5
C	Semi-Indaing	Red loamy soil	610 to 910	Dry-13	12	10	9
				Wet- 5	5	5	5

5.4.2 Results

The field readings were used to calculate values of sorptivity, hydraulic conductivity, cumulative infiltration and rate of infiltration. Computations were done at the University Computer Centre, Rangoon, and the detailed results are given in Appendix 5.8.

The computations are summarized in Tables 5.12 and 5.13 which show the cumulative infiltrations for various time periods and forest types for the dry season and wet season measurements respectively. The detailed computations are shown in Appendix 5.9.

5.4.3 Analysis and statement of results

The results summarized in Tables 5.12 and 5.13 are shown in Figures 5.13 and 5.14. Figure 5.13 shows the cumulative infiltrations for periods up to five hours for the three forest types, mixed deciduous, man made and semi-indaing in the dry season. Similarly Figure 5.14 shows the results for the wet season.

Table 5.12 Cumulative infiltration for different types of forests in Kyetmauk-taung catchment area Burma (dry season results)

Time (min.)	Cumulative infiltration (cm)								
	Mixed deciduous (20 samples)			Plantation (20 samples)			Semi-indaing (20 samples)		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
1	1.44	2.37	1.91	1.30	2.16	1.73	1.01	2.13	1.54
6	4.21	6.64	5.41	3.96	5.94	4.83	2.83	5.98	4.29
12	6.61	10.22	8.34	6.28	9.04	7.42	4.32	9.22	6.58
18	8.71	13.29	10.88	8.18	11.68	9.64	5.60	12.05	8.54
30	12.45	18.75	15.39	11.46	16.59	13.58	7.86	17.56	12.01
60	20.12	30.66	25.26	18.55	27.76	22.15	12.75	30.03	19.54
120	33.50	51.64	42.71	30.69	47.85	37.21	21.29	52.88	32.75
180	45.76	71.02	58.88	41.36	66.67	51.10	29.15	74.54	44.91
360	79.83	125.3	104.2	69.31	120.0	89.93	51.01	136.6	78.83

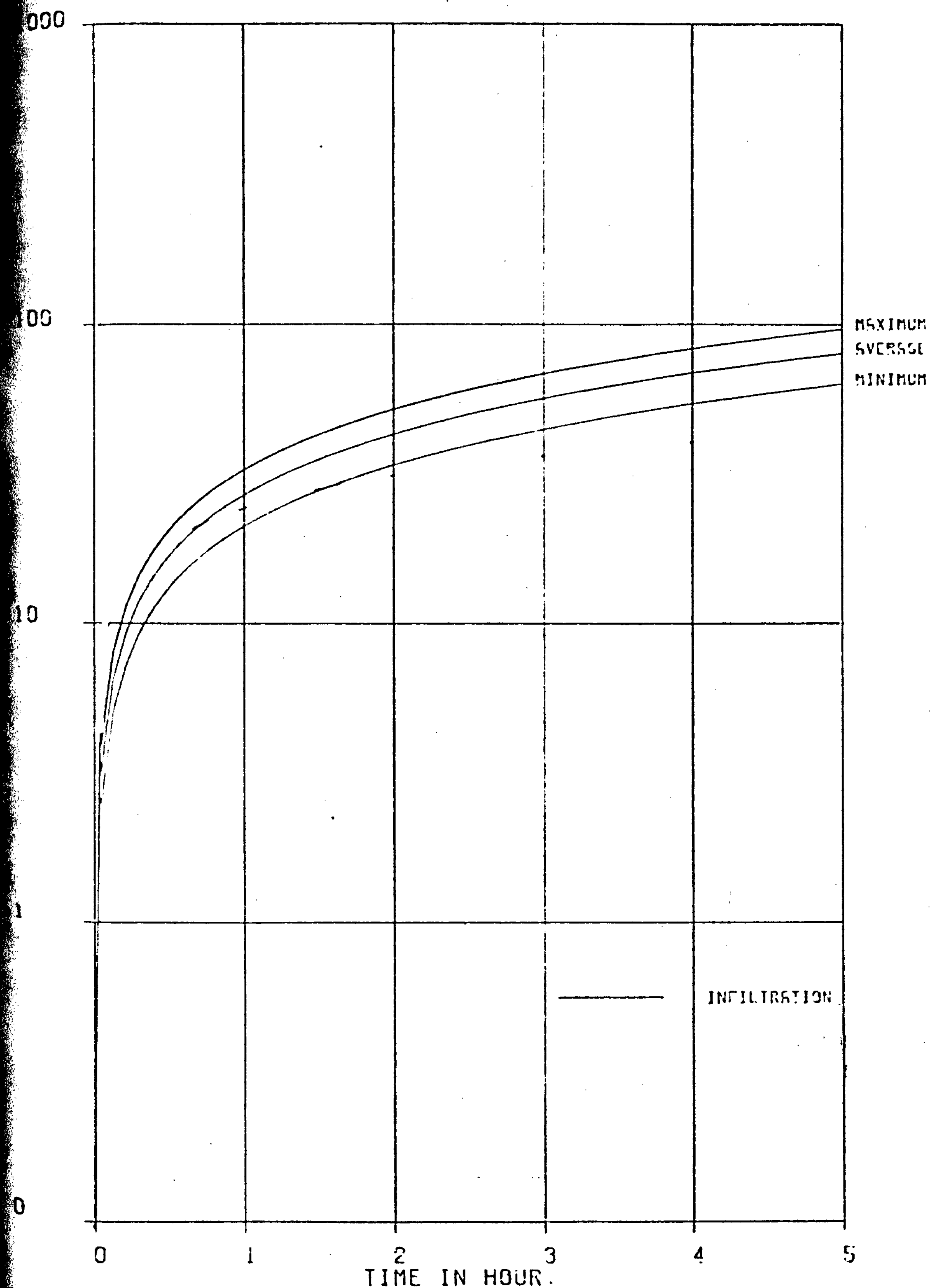
Table 5.13 Cumulative infiltration for different types of forests in Kyetmauk-taung catchment area Burma (wet season results)

Time (min.)	Cumulative infiltration (cm)								
	Mixed deciduous (20 samples)			Plantation (20 samples)			Semi-indaing (20 samples)		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
1	1.01	1.89	1.39	1.22	1.63	1.40	0.82	1.44	1.15
6	2.51	4.70	3.45	3.04	4.04	3.49	2.03	3.57	2.86
12	3.61	6.71	4.94	4.34	5.76	4.98	2.90	5.09	4.08
18	4.46	8.28	6.10	5.36	7.10	6.14	3.58	6.28	5.03
30	5.85	10.81	7.98	7.00	9.26	8.02	4.68	8.18	6.57
60	8.52	15.61	11.57	10.11	13.35	11.59	6.95	11.78	9.46
120	12.53	22.71	16.91	14.72	19.37	16.87	9.82	17.08	13.74
180	15.80	28.41	21.22	18.43	24.10	21.12	12.29	21.31	17.16
360	23.79	42.08	31.67	27.32	35.72	31.32	18.20	31.39	25.34

ULATIVE INFILTRATION

KYETMAUKTAUNG CATCHMENT, BURMA [DRY SEASON]

MIXED DECIDUOUS FOREST TYPE



[UMULATIVE INFILTRATION

KYETMAUKTAUNG CATCHMENT, BURMA [DRY SEASON]

MAN-MADE FOREST TYPE

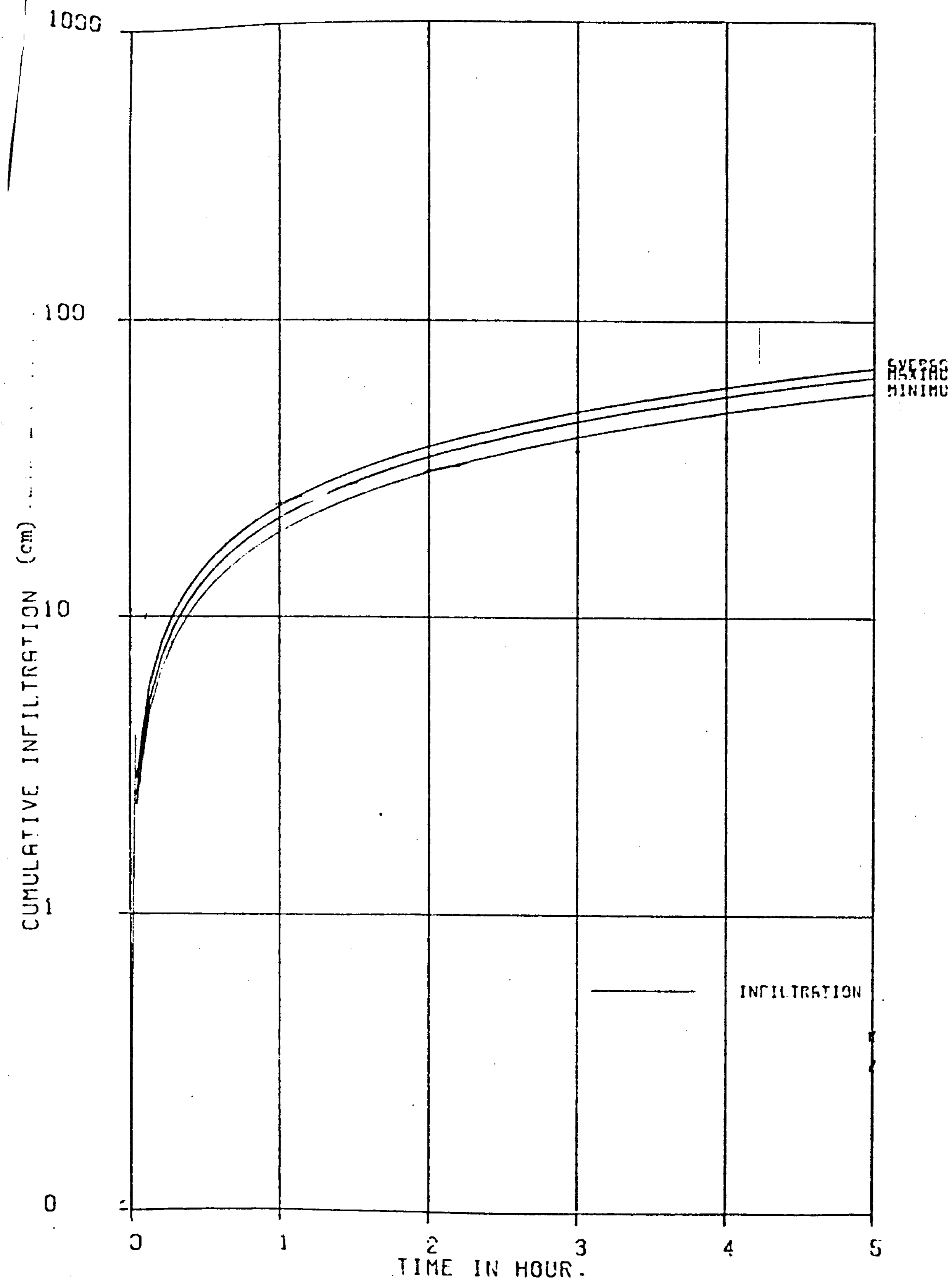
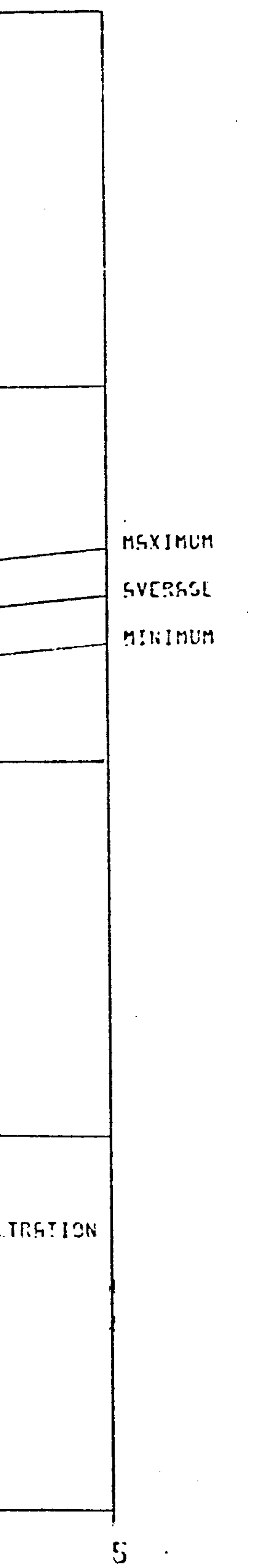


Figure 5.

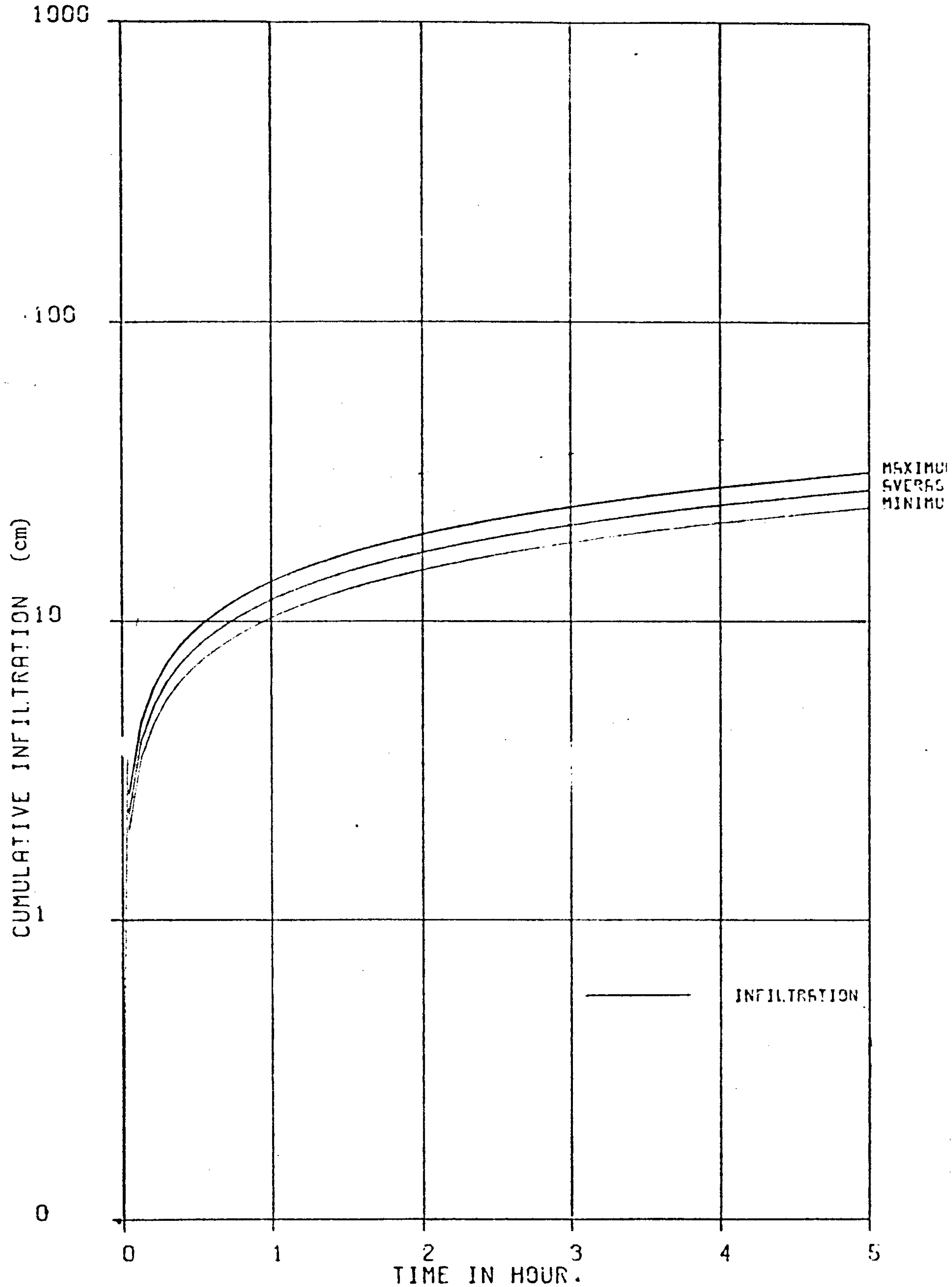
ON]



CUMULATIVE INFILTRATION

KYETMAUKTAUNG CATCHMENT, BURMA [WET SEASON]

MAN-MADE FOREST TYPE



CUMULATIVE INFILTRATION

KYETMAUKTAUNG CATCHMENT, BURMA [WET SEASON]

SEMI-INDAING FOREST TYPE

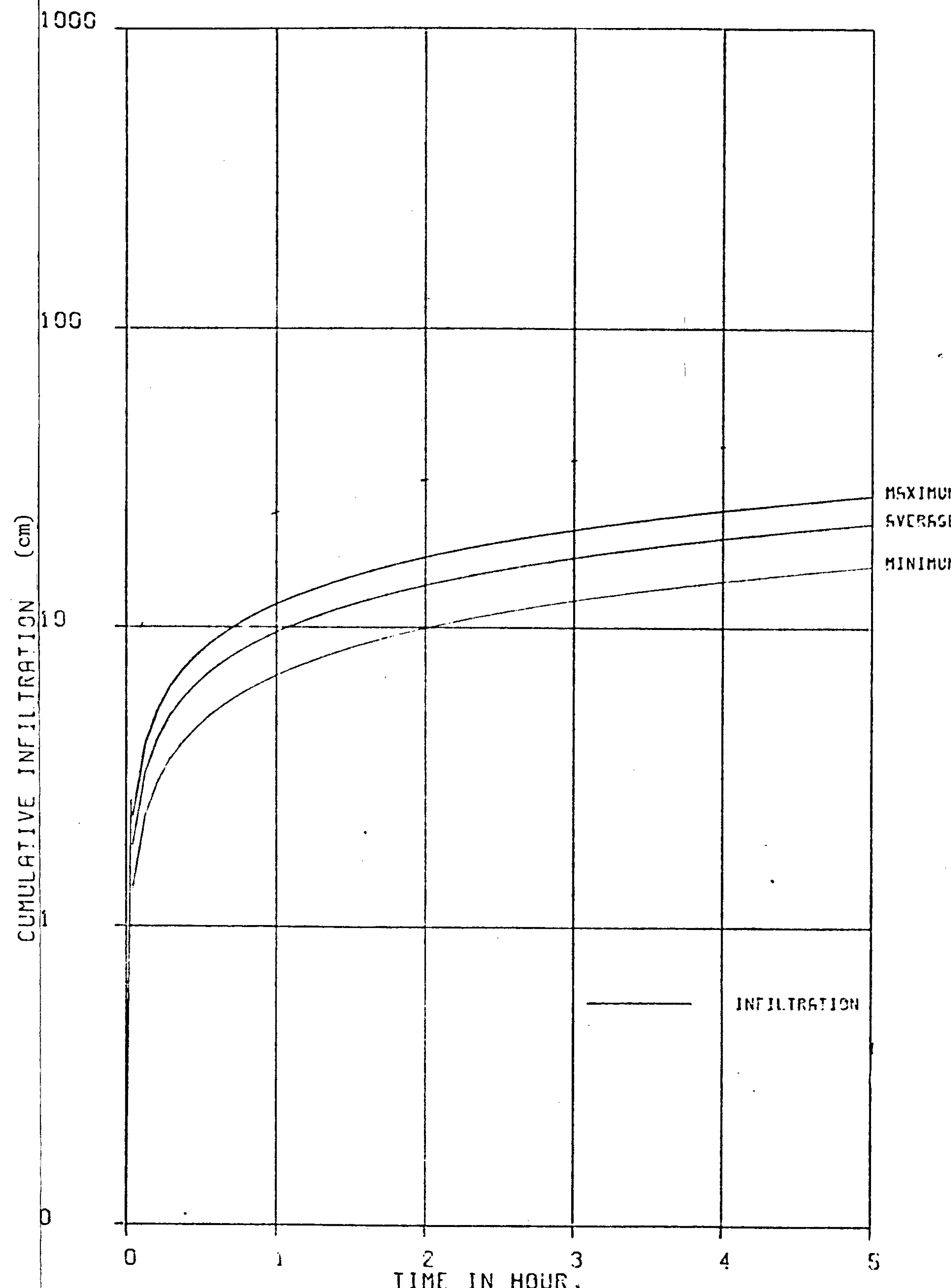
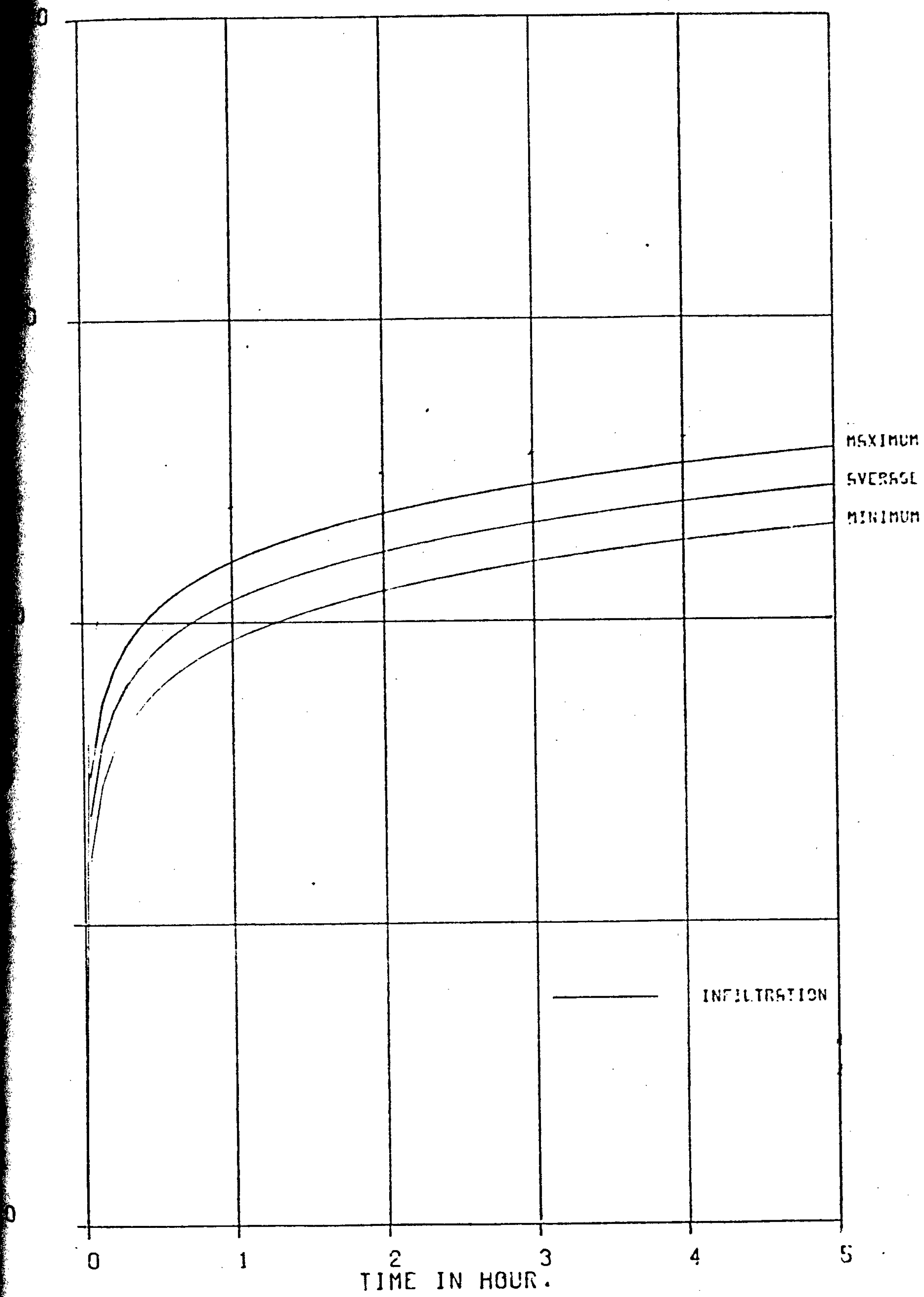


Figure 5.14

ATIVE INFILTRATION

KYETMAUKTAUNG CATCHMENT, BURMA [WET SEASON]

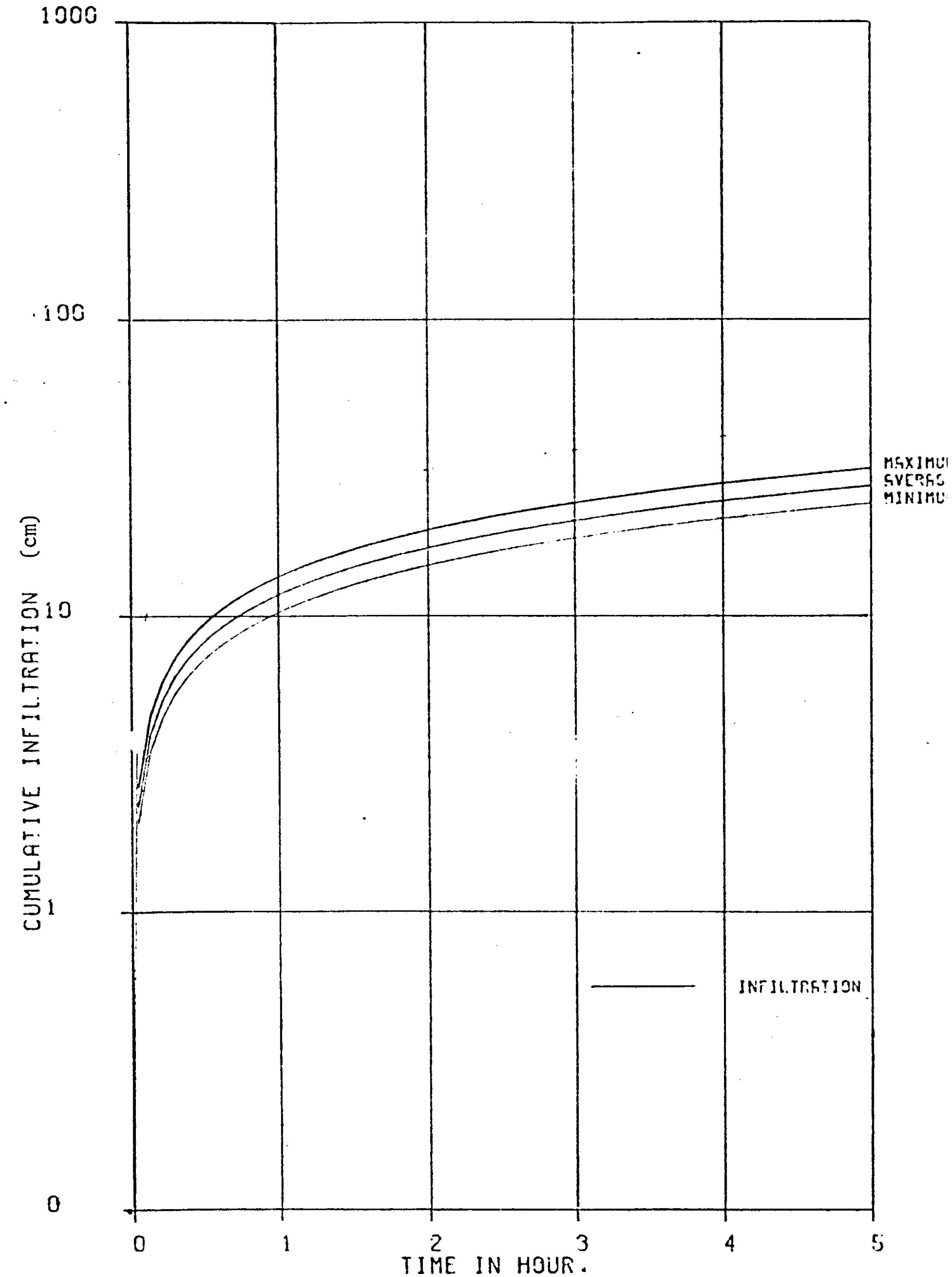
MIXED DECIDUOUS FOREST TYPE



CUMULATIVE INFILTRATION

KYETMAUKTAUNG CATCHMENT, BURMA [WET SEASON]

MAN-MADE FOREST TYPE



CU

CUMULATIVE INFILTRATION (cm)

5.4.3.1 Statistical analysis of dry season results

The results of the analysis of variance for variation between blocks and treatments is shown in Appendix 5.10.

On the basis of cumulative infiltration at 1 minute there is no significant difference between the four blocks while there is a highly significant difference between treatments, that is the three forest types.

The average cumulative infiltration after 1 minute is shown for each block and for each treatment in Table 5.14.

The results of the analysis for significant differences between the individual forest types on the basis of cumulative infiltration after a period of 1 minute is shown in Appendix 5.11.

Table 5.14 Average cumulative infiltration after 1 minute by blocks and forest types.
Dry season, Kyetmauk-taung catchment (cm)

Forest type	Block No. I	II	III	IV	Mean (forest type)
Mixed deciduous	1.94	1.95	2.06	2.04	1.99
Man-made plantation	1.78	1.38	1.69	1.65	1.75
Semi-Indaing	1.36	1.42	1.38	1.51	1.42

On the basis of the cumulative infiltration after 1 minute there are highly significant differences between the mixed deciduous forest type and the man-made plantation, between the mixed deciduous forest and the semi-indaing forest and between the man-made plantation and the semi-indaing forest. The results are summarized below.

Comparison	Level of significant difference (cumulative infiltration)
Mixed deciduous and man-made plantation	** highly significant
Mixed deciduous and semi-indaing	** highly significant
Man-made plantation and semi-indaing	** highly significant

The results of the analysis of variance and the testing for significant difference between forest types on the basis of sorptivity are shown in Appendix 5.12 and summarized below.

Comparison	Level of significant difference (sorptivities)
Mixed deciduous and man-made plantation	* significant
Mixed deciduous and semi-indaing	** highly significant
Man-made plantation and semi-indaing	** highly significant

The results of the analysis of variance and the testing for significant difference between forest types on the basis of hydraulic conductivity are shown in Appendix 5.13 and summarized below.

Comparison	Level of significant difference (hydraulic conductivity)
Mixed deciduous and man-made plantation	** highly significant
Mixed deciduous and semi-indaing	** highly significant
Man-made plantation and semi-indaing	** highly significant

The results of the analysis of variance and the testing for significant difference between forest types on the basis of the cumulative infiltration at 1 minute are shown in Appendix 5.14 and summarized below. This is a similar test as that shown in Appendix 5.11 but all plots (133) have been lumped together as was done for the results shown in Appendices 5.12 and 5.13.

Comparison	Level of significant difference (infiltration at 1 minute)
Mixed deciduous and man-made plantation	* significant
Mixed deciduous and semi-indaing forest	** highly significant
Man-made plantation and semi-indaing	** highly significant

5.4.3.2 Statistical analysis of wet season results

The results are shown in Appendix 5.15 and summarized below.

Comparison	Level of significant difference
Mixed deciduous and man-made plantation	not significant
Mixed deciduous and semi-indaing forest	** highly significant
Man-made plantation and semi-indaing	** highly significant

The analysis thus shows on the basis of cumulative infiltration after 1 minute, that there are highly significant differences between the mixed deciduous and the semi-indaing forest and between the man-made plantation and the semi-indaing forest but that there is no significant difference between the mixed deciduous forest and the man-made plantation.

5.4.3.3 Comparison of dry season and wet season results

The comparison is summarized on the basis of average cumulative infiltration in Table 5.15.

Table 5.15 Comparison of cumulative infiltration (average) in the dry and wet season

Forest type	Cumulative infiltration (cm)			
	1 min.		60 min.	
	dry	wet	dry	wet
Mixed deciduous	1.92	1.39	25.2	11.6
Plantations	1.73	1.40	22.1	11.6
Semi-indaing	1.54	1.15	19.5	9.4

5.4.4 Discussion

There is much less variability in the measured values of sorptivity and hydraulic conductivity within the measurements taken in the Kyetmauk-taung catchment than within the measurements taken in the Cotter catchment and the randomized block design for the sampling has enabled significant differences to be established on a statistical basis.

While in the dry season the infiltration characteristics of the man-made plantations are significantly different to those in the mixed deciduous forest, and are generally lower, they are higher than the semi-indaing forest.

The man-made plantations were established to rehabilitate eroding areas under banana plantations in 1969-70. Since that time it has been observed that the base flows of the small streams are higher and that small springs now flow later into the dry season than they did under the banana plantations. This field observation suggests that infiltration of rainfall has increased as a consequence of the rehabilitation and is confirmed by the results of the study for the infiltration characteristics on the brown volcanic soils are approaching the values for the black volcanic soils of the mixed deciduous forest.

The man-made plantations are located on land which was covered with mixed deciduous forest before it was cleared for banana plantations. While it deteriorated under its use for banana plantations the results of the study suggest that reafforestation has in the short period since 1969-70 restored the infiltration characteristics to values approaching those in the undisturbed and adjacent mixed deciduous forest.

CHAPTER VI

THE DERIVATION OF RAINFALL INTENSITY-DURATION-FREQUENCY DIAGRAMS FOR STATIONS IN THE LOWER COTTER CATCHMENT AND RAINFALL INTENSITIES FOR KYETMAUK-TAUNG CATCHMENT

6.1 INTRODUCTION

The measurement of rainfall is the basis for all hydrologic and hydrometeorologic studies. Horton (1919), suggests that rainfall was probably the meteorological element first measured by man. There is evidence that rainfall records were kept in India in the fourth century B.C. It is known that rain gauges of some sort were used in Korea in A.D. 1442. The modern type of non-recording gauge came into use in Europe late in the fifteenth century, (Linsley *et al.*, 1949).

The measurement of rainfall intensity is a relatively recent innovation. Recording gauges, or pluviographs, are used to determine the intensity by measuring the depths of rainfall over relatively short periods.

Pluviograph readings for rainfall started in Australia in about 1948 (Pierrehumbert, 1972). Since that time the amount of pluviograph data has increased enormously and the Bureau of Meteorology has now published rainfall intensity-duration-frequency diagrams for the capital cities of Australia (Pierrehumbert, 1974).

Rainfall intensity is significant in the generation of ponding and overland flow, for when rainfall intensity exceeds the infiltration rate ponding occurs. Fleming and Smiles (1975) note that the transition to ponded infiltration under rainfall conditions is of fundamental importance to hydrologists since it defines the starting time of a surface water surplus leading to overland flow. They illustrated the relationships between infiltration rate, time and rainfall rate as in Figure 6.1.

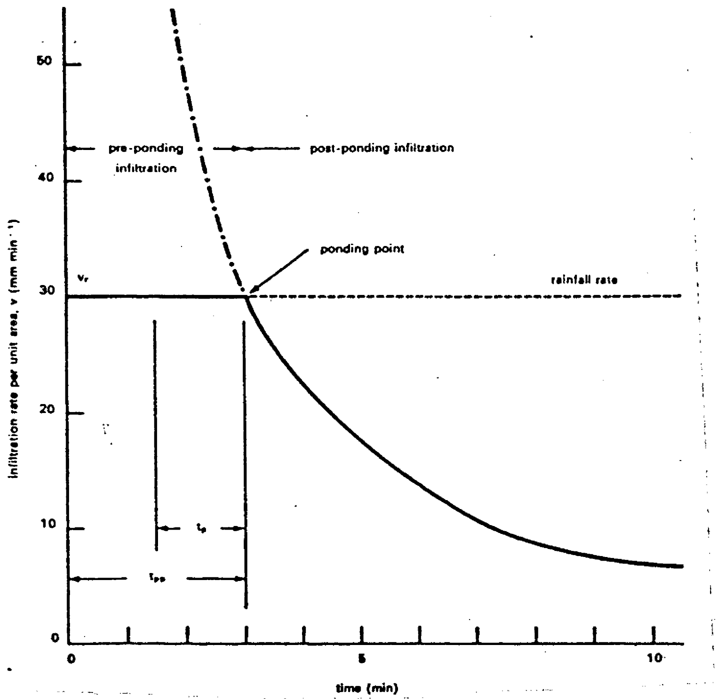


Figure 6.1 Infiltration rate vs time under a steady rainfall rate, v_r: ______ infiltration curve; __.__.__.__, ponded extended back to t_p=0; ----------, rainfall rate
Source: Fleming and Smiles (1975)

Where vegetation provides a buffer between rainfall and the soil surface the intensity of the throughfall at a point may vary considerably for Thistlethwaite (1970) has shown that the spatial variability of throughfall is much greater than for rainfall. However, throughfall intensities are not available and for this study of infiltration rates it was accepted that the measured infiltration rates, as presented in Chapter V would have to be compared with rainfall intensity. This approach conforms to that adopted in the model developed in connection with the Australian Representative Basin Model, Australian Water Resources

Council (1969). The model is illustrated conceptually in Figure 6.2. An interception store is extracted from the rainfall before in simulation it acts on the infiltration function and possibly generates depression storage.

There were no direct data available for rainfall-intensity-frequencies at the proposed study sites. Pluviographs were in operation at some meteorological stations in the Cotter catchment but there were no measurements of intensities in the Kyetmauk-taung catchment. A pluviograph was installed on Mt Poppa in connection with this study (see Plate 6.1). It will be some years before sufficient records are available to predict the relationship between rainfall intensity-duration-frequency.

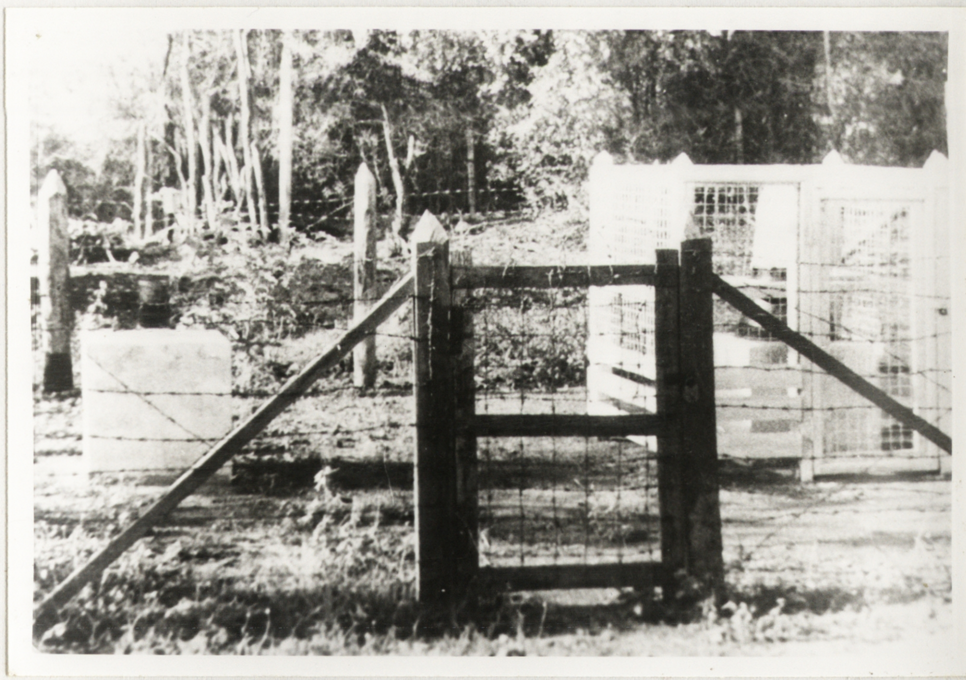


Plate 6.1 Pluviograph at Mt Poppa Station

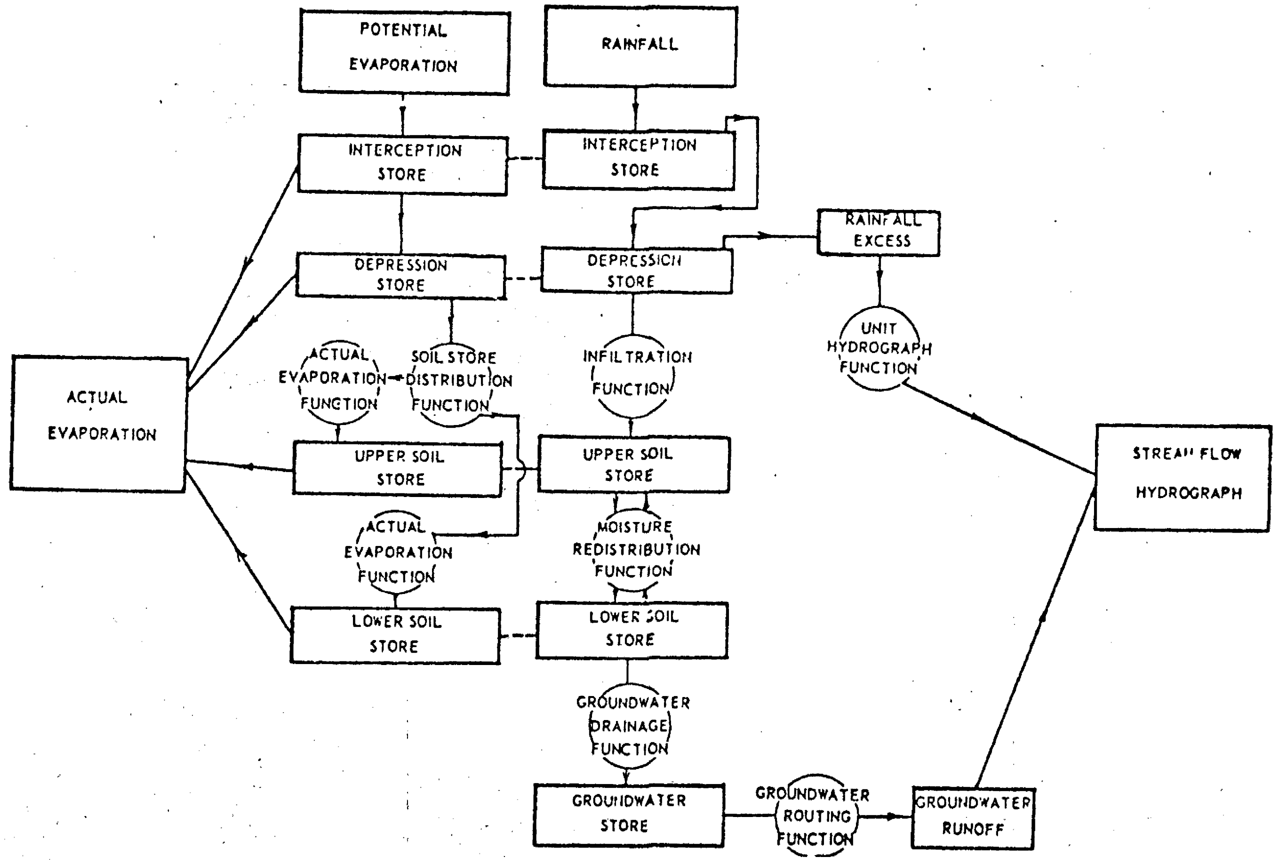


Figure 6.2 The Representative Basin Model (after AWRC, 1969, 1974)

The rainfall patterns at the two study areas are of course markedly different. The mean monthly rainfall in the 'temperate' and 'tropical' study areas was given in Tables 4.1 and 4.2 and shown in Figures 6.3 and 6.4.

The results of the data collection processing and analysis to provide estimates of rainfall intensities and their duration, for comparison with infiltration rates, are presented in the following sections.

6.2 THE ANALYSIS OF RAINFALL RECORDS IN THE COTTER CATCHMENT

In connection with this study for the comparison of infiltration rates with rainfall intensity it was required to determine the variation of rainfall within relatively short periods (minutes) and up to large periods of several hours.

The Institution of Engineers, Australia, published in 1958 'Australian Rainfall and Runoff'. This publication was the main reference for engineering hydrologists until the publication in 1977, again by the Institution of Engineers, of a second publication on Australian Rainfall and Runoff titled 'Flood Analysis of Design'. This reference material was not available at the time of the field measurements undertaken in the Cotter catchment. The information for the preparation of the publication was compiled with the cooperation of the Commonwealth Bureau of Meteorology and to prepare adequate estimates of rainfall for various time periods all Australian pluviograph records which covered a period of 15 years or more were examined in detail by computer. Rainfall intensity-frequency-duration curves were prepared as illustrated for Canberra in Figure 6.5 and in detail in Appendix 6.1.

Publication of information in the form illustrated in Figure 6.5 requires an estimate of the rainfall amounts which will be equalled or exceeded in a given duration at a given point. Two assumptions must be

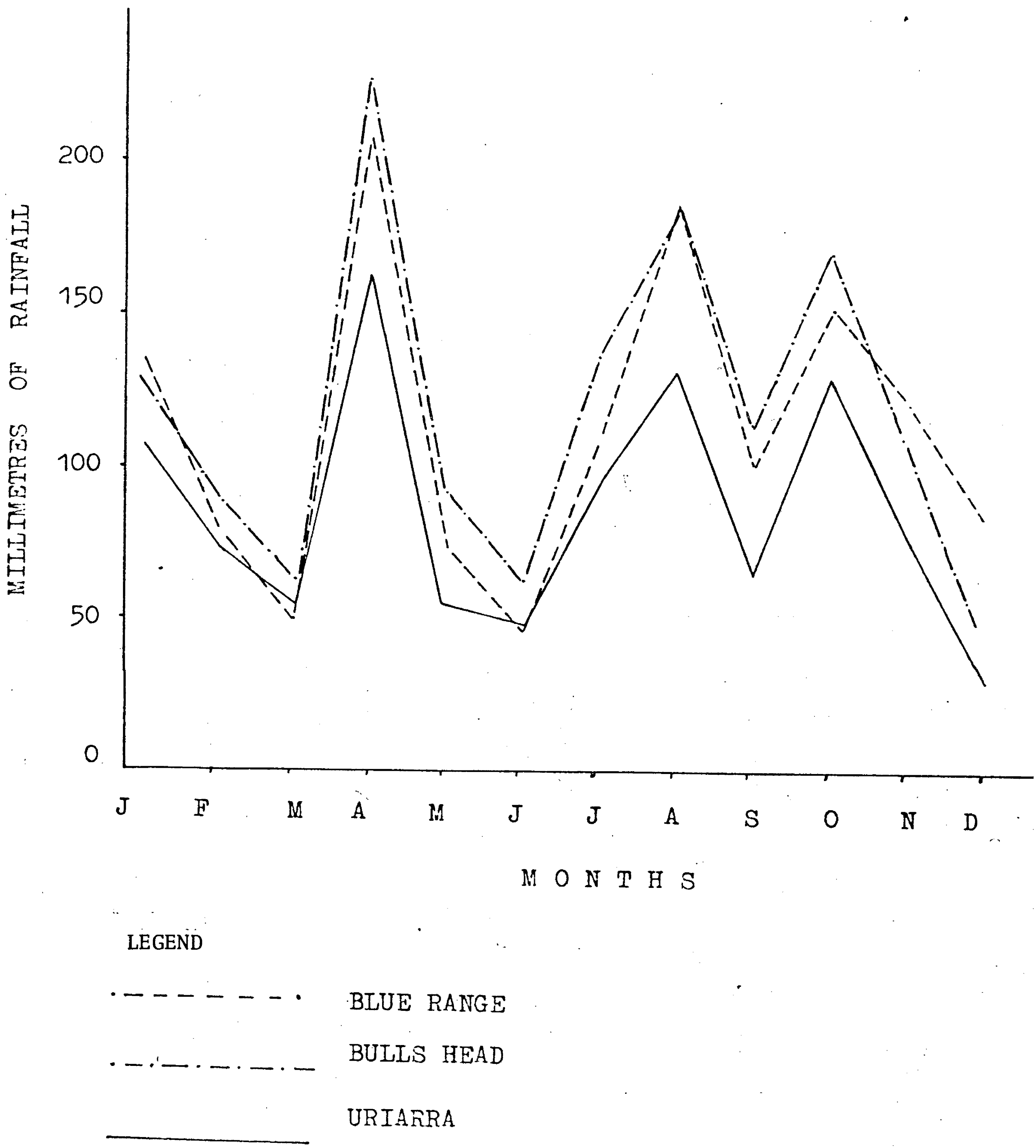


Figure 6.3 Variability of rainfall at Uriarra-Blue Range-Bull's Head

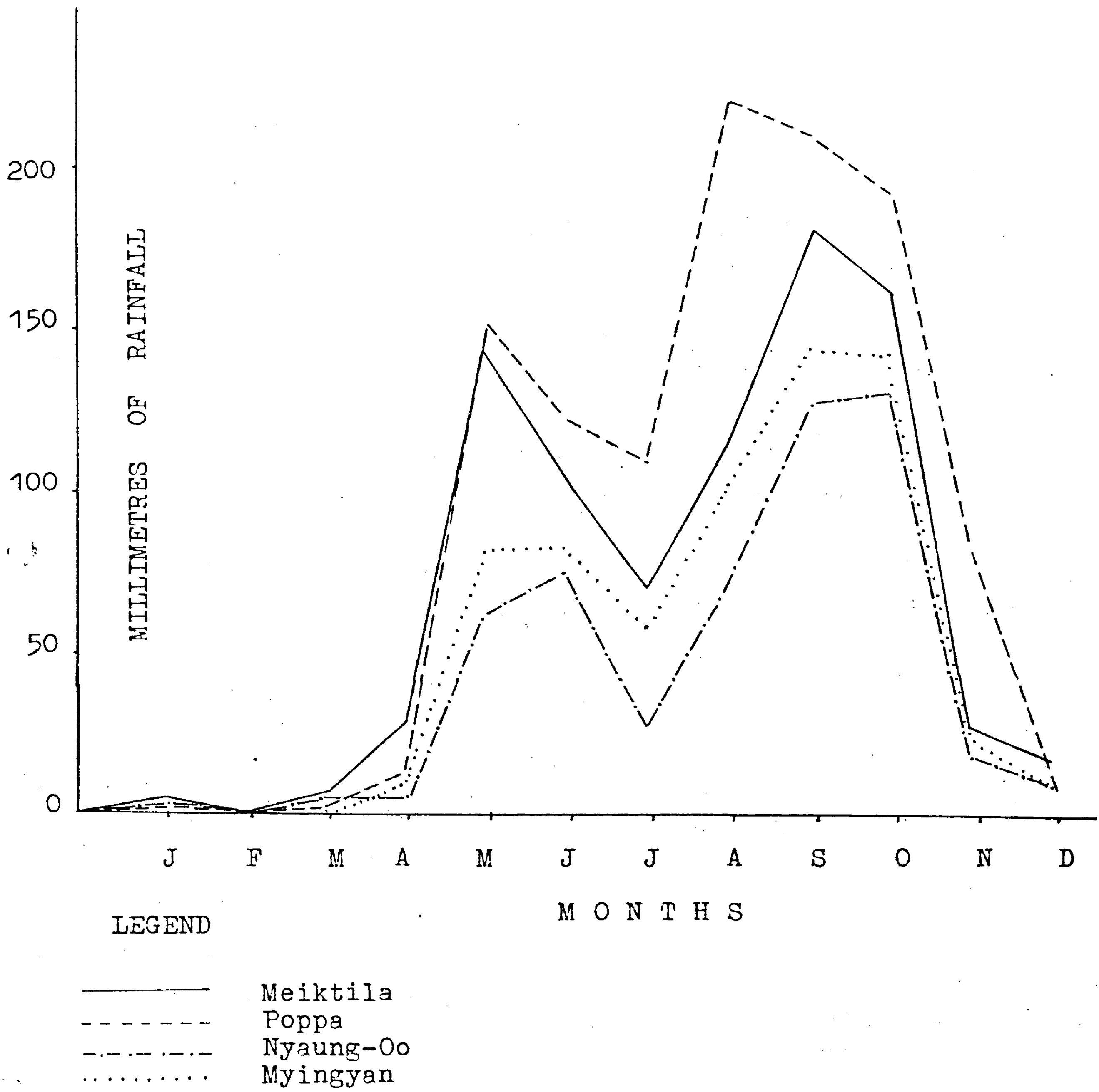


Figure 6.4 Variability of rainfall at Meiktila, Poppa, Nyaung-oo, Myingyan

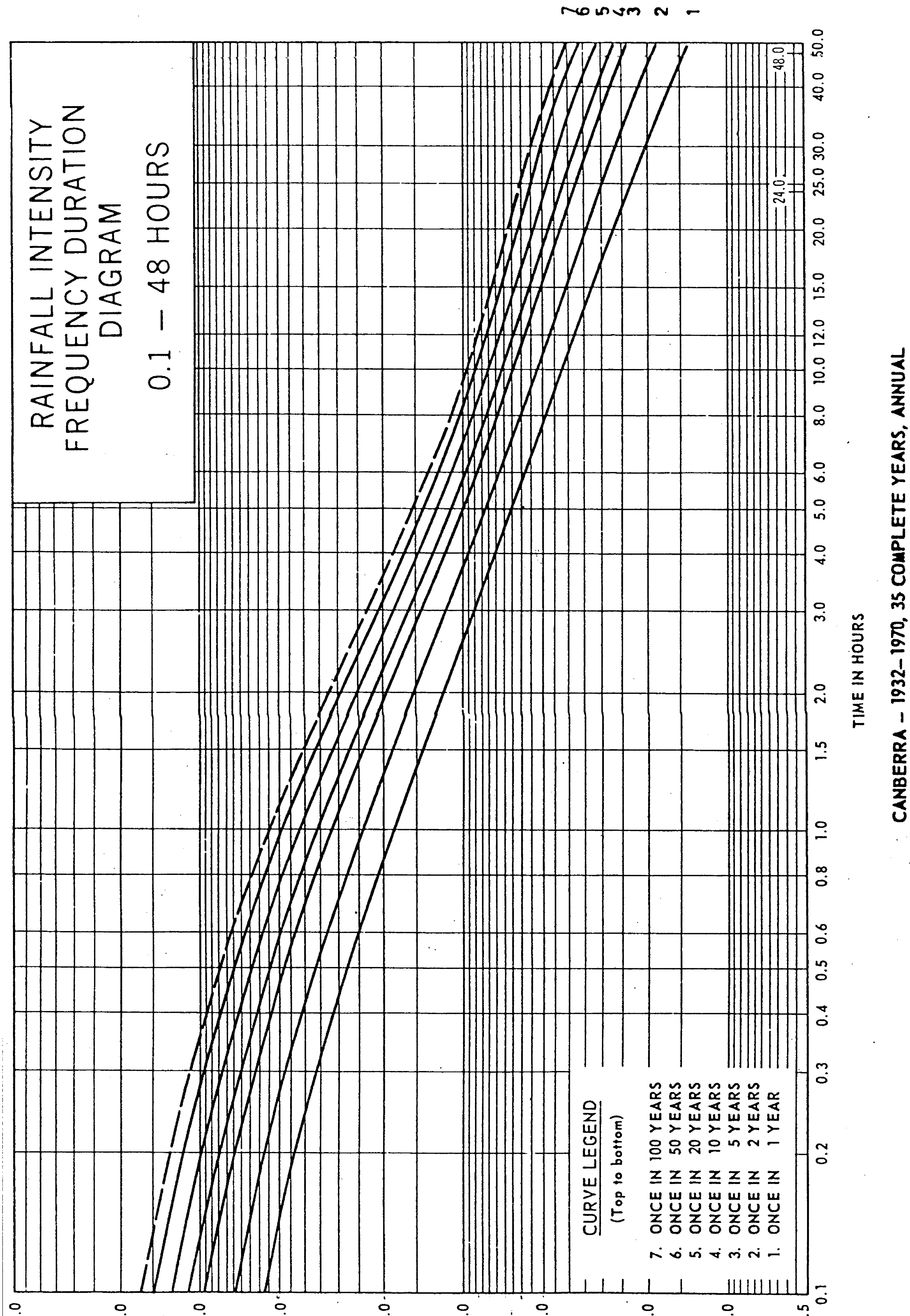


Figure 6.5
Source: Pierrehumbert (1974)

made (Pierrehumbert, 1972).

(1) The available observations are an unbiased sample of rainfall experience for the observation point in question.

(2) There is no climatic trend at the point.

The following three characteristics of the estimates are also desirable, again after Pierrehumbert (1972).

(1) They should be compatible with past observations.

(2) Estimates for a given station for a given duration and return period should be consistent with estimates for the same station for the same duration and other return periods, as well as for the same period and other durations.

(3) There should be consistency between estimates for given durations and return periods at neighbouring stations, unless some factor, such as local orography, introduces significant differences.

6.2.1 Methods of analysis

While giving consideration to an approach to the problem of determining rainfall intensities which could be reasonably compared with infiltration rates there was an opportunity to visit Melbourne and Mr Pierrehumbert of the Commonwealth Bureau of Meteorology made himself available for discussions. The author is indebted to Mr Pierrehumbert for his comments, advice on the problems and the reference material he provided.

There are two distinct approaches which can be made to the analysis of heavy rainfall data. The first of these involves the consideration of all heavy falls and such a series is usually referred to as the partial duration series. However if it is desired to fit a mathematical distribution to the observed data then each element must be independent of all of the others. A primary series is then used which includes the highest and only the highest observed value for each season or year considered. It is not uncommon for several falls in one particular year to be heavier than the greatest fall in another year. Thus the partial duration series will include a number of terms not included in the primary series and likewise, some of the terms in the primary series will be too small to be included in the partial duration series.

Pierrehumbert (1972) discusses four alternative methods of analysis.

1. The Californian method

In this method the highest N falls of a given duration in N years of record, that is the first N terms of the partial duration series are listed in ascending order. More than one fall may be taken from a particular year and none at all from others. These are plotted on a graph of rainfall against percentage occurrence, the first observation being plotted 100/2N, the second at 300/2N and so on. The value for any return period is obtained by converting the return period to a percentage chance and then interpolating between points on the graph. Appendix 6.2 shows 25 years of 1 hour rainfalls for Cairns analysed by the Californian method.

The method fits the observations exactly but cannot be used to extrapolate, that is for example the once in 100 years event cannot be found from 40 years of record. The method also lacks consistency between observations and with neighbouring stations.

2. Fitting distributions

A well known mathematical distribution such as the normal distribution, transformations of the normal distribution or the incomplete gamma distribution is fitted to the primary series.

The method has the advantage of making the most 'efficient' use of the available data. Estimates for a given return period are not strongly dependent on one or two values and as a result there is greater interval consistency. The method is also amenable to extrapolation. However, because of sampling errors, relationships between analyses of different durations tend to be inconsistent, particularly for the large return periods.

3. A third method is to develop relationships either empirically or by the use of distribution functions to relate rainfall for any return period to that for two fixed return periods and for any duration to two fixed durations. The method removes the problem of interval inconsistencies and consistency between neighbouring stations is relatively easy to obtain. However the method can create discrepancies between the estimates produced and past rainfall experience.

4. The Institution of Engineers, Australia (1958) used a formula to calculate rainfall intensity for a return period of 'y' years

$$P_y = \frac{C}{(t-b)^n} F_y \qquad (6.1)$$

P_y = rainfall intensity for a return period of y years

F_y is the 'frequency function' and is a function of the standard deviation of the logarithms of the primary falls and the return period

t is the duration of the fall in minutes

C, b and n are functions of geographic location.

Charts were produced from which estimates for any duration and any return period could be made for any point in Australia.

The Institution of Engineers approach was greatly handicapped by very limited pluviograph data and an indirect approach was adopted to estimate rainfall for durations less than 24 hours and apart from the capital cities all estimates were based on the standard deviation of the calendar day primary rainfalls.

5. In connection with the analysis of Australian pluviograph data the Commonwealth Bureau of Meteorology produced a number of computer packages. One of these, the 'B14 programme' produced information on rainfall intensity-duration-frequency as a graph. An example is shown in Appendix 6.3. Pierrehumbert (pers. comm.) advised that although the period of record of the pluviograph stations in the lower Cotter catchment was short for the derivation of diagrams the processing of the available records would give more reliable information than transposition of data from other stations and in particular from Canberra.

The 'B14 programme' was therefore selected as the principal analytical procedure for the derivation of rainfall intensities at the study sites.

6.2.2 Pluviograph records in the Lower Cotter Catchment

6.2.2.1 Introduction

Forest watershed research on a long term basis commenced in the lower Cotter catchment after the formation of the Watershed Management Sub-section of the Research Branch of the Forestry and Timber Bureau (now with the Division of Forest Research, CSIRO) in December 1962. The experimental catchment programme was commenced in 1963 with the following objectives (Moreland, pers. comm.).

. To determine the hydrologic characteristics of a series of forested catchments located in varying vegetation, climate, soil and topographic conditions by precise measurement of streamflow and meteorological factors.

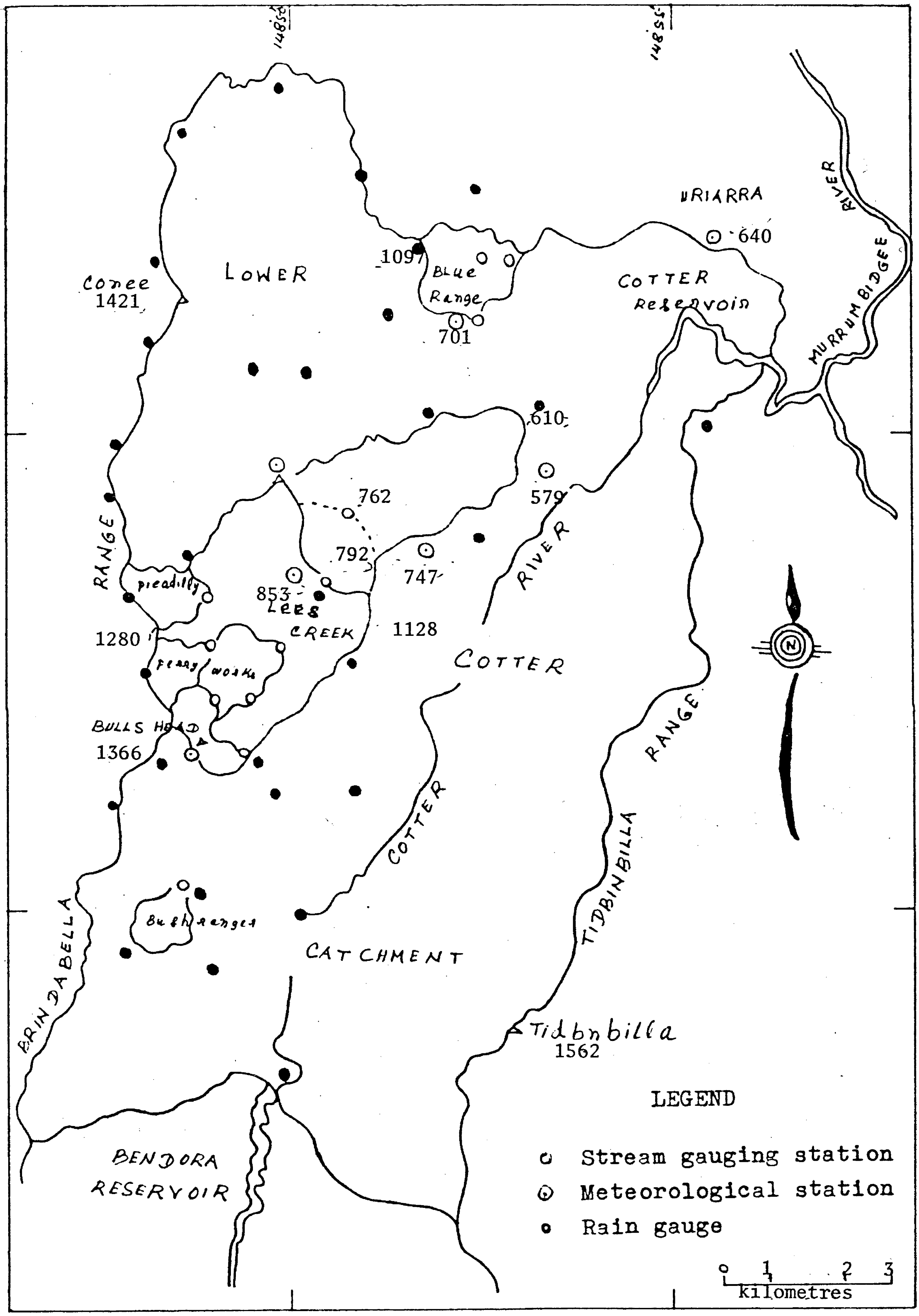
- From such data, construct a hydrologic model for forested catchments.
- After an adequate calibration period determine the effects of various forest management treatments on streamflow, water quality, nutrient loss from the ecosystem and other catchment characteristics.
- Carry out associated studies on such aspects as interception, infiltration, sedimentation and the nutrient cycle.

Sixteen experimental catchments and a series of meteorological stations are now located in the lower Cotter catchment.

The location of the hydrometeorological stations is shown in Map 6.1. The length of record of the recording rainfall gauges is shown in Table 6.1.

Table 6.1 Pluviograph rainfall stations in lower Cotter catchment: Australian Capital Territory operated by Watershed Research Section, Division of Forest Research

Station name	No.	Latitude	Longitude	Elevation (m)	Beginning of record
Uriarra	570001	35°18'	148°56'	625	1963
Blundell	570002	35°21'	148°50'	1050	1963
Vanity's	570005	35°21'	148°54'	580	1963
Lees Creek	570008	35°22'	148°51'	820	1963
"	570013	35°19'	148°52'	700	1963
Blue Range	570031	35°19'	148°52'	700	1965
Bull's Head	570032	35°23'	148°49'	1370	1965
"	570033	35°23'	148°49'	1100	1965
Blundell's Creek Road	570036	35°25'	148°49'	980	1967
"	570037	35°24'	148°50'	1170	1968
"	570039	35°23'	148°50'	1200	1968
"	570045	35°22'	148°49'	1070	1968
"	570047	35°20'	148°49'	850	1971
"	570048	35°21'	148°51'	760	1971
"	570050	35°22'	148°50'	880	1971



Map 6.1 Lower Cotter catchment rain gauge network

The analogue charts from these recording gauges were made available by the Division of Forest Research for analysis in connection with this study. While records were available for fifteen pluviographs the stations had, as shown in Table 6.1, a very short period of record. Since the main purpose of the derivation of rainfall intensity-duration-frequency diagrams was for comparison with infiltration rates it was decided to process the records for the Blue Range and Bull's Head stations.

6.2.2.2 Processing of analogue charts

Checking

In addition to the pluviograph data weekly rainfall (for Uriarra station daily) is recorded at the meteorological stations by means of 20.3 mm (8") rain gauges.

The analogue charts were examined to see that the rainfall totals measured by the pluviograph conformed with the weekly read gauge and thus ensure that there was no malfunction of the recording equipment. The time that rain begins and ends must also be noted on the chart and each analogue chart was marked in this way.

After checking and recording the times of the rain events the charts for each station were assembled in separate years.

Preparation for computing

The former Division of Land Research of the CSIRO had developed a chart processor for converting analogue charts to magnetic tape and after a training period extending over two weeks processing of the checked analogue charts was commenced. Initially each rainfall event on the analogue chart must be traced on to a strip chart to provide continuity in the trace and a discrete record. The time that rainfall begins and ends is shown on the trace. It took at least two days per station year to check and prepare the analogue charts.

It had been intended to process additional stations, including Uriarra station, but time did not permit this.

The record traced on the strip chart must then be digitized and stored on the magnetic tape.

The Commonwealth Bureau of Meteorology agreed to process the strip charts on to magnetic tape and all the strip charts prepared were sent to Melbourne for computation with the B14 programme.

6.2.2.3 Calculated rainfall intensities

The calculated values of rainfall totals in millimetres as derived from the processed records for various durations and frequencies are shown in Appendices 6.4 and 6.5 for Bull's Head and Blue Range respectively.

Extracts are shown in Table 6.2.

Table 6.2 Rainfall-duration-frequencies at Bull's Head and Blue Range

Rainfall duration (mins)	Rainfall totals in millimetres, Frequency (once in n years)					
	1		2		10	
	Bull's Head	Blue Range	Bull's Head	Blue Range	Bull's Head	Blue Range
6	7.5	6.0	10.1	7.6	18.0	10.6
12	11.3	9.0	15.2	11.4	26.5	15.7
18	14.5	11.5	19.5	14.6	34.6	20.5
30	18.6	14.7	25.2	18.7	45.7	26.5
60	23.6	18.7	31.8	23.7	56.8	32.7
120	28.8	23.5	38.0	29.3	61.8	38.2
720	58.7	52.3	72.8	65.1	92.0	83.5
1440	74.3	66.5	94.4	84.2	129.9	113.9

Table 6.2 was recalculated to express the rainfall totals as rainfall intensities in mm/hour as shown in Table 6.3.

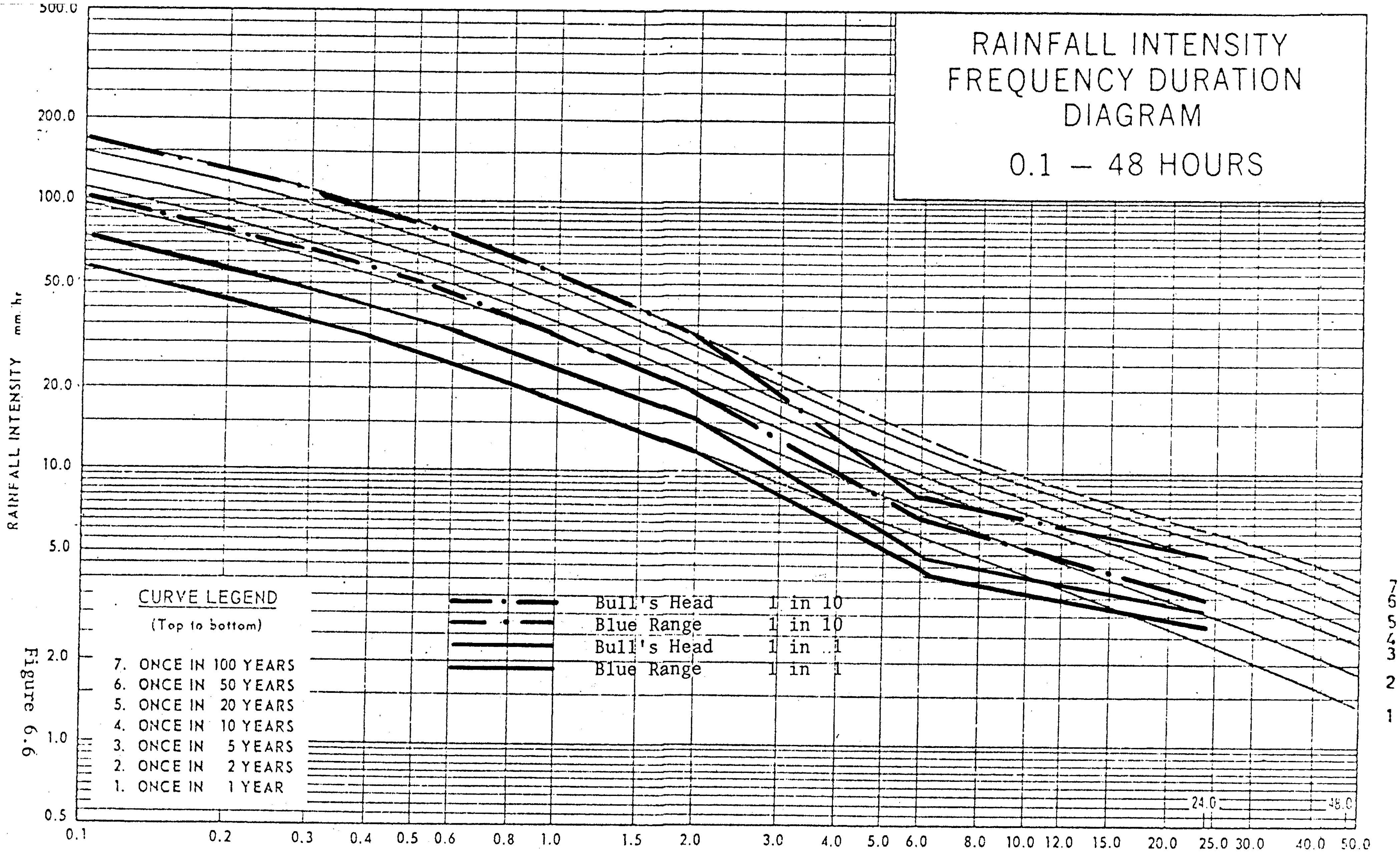
Table 6.3 Rainfall intensity-duration-frequencies at Bull's Head and Blue Range

Rainfall duration (mins)	Rainfall intensities mm/hour Frequency (once in n years)					
	1		2		10	
	Bull's Head	Blue Range	Bull's Head	Blue Range	Bull's Head	Blue Range
6	75	60	100	76	180	106
12	56	45	76	57	132	79
18	48	38	65	49	115	68
30	37	29	50	37	91	53
60	24	19	32	24	57	33
120	14	12	19	15	31	19
720	4.9	4.4	6.1	5.4	7.7	7.0
1440	3.1	2.7	3.9	3.5	5.4	3.7

6.2.2.4 Review

The rainfall intensities shown in Table 6.3 are also shown in Figure 6.6 which shows by way of comparison the intensities for Canberra as presented in Figure 6.5.

As would be expected with the increasing elevations the rainfall intensities increase in moving from Canberra to Blue Range to Bull's Head and there seems little doubt that the values of rainfall intensities calculated from the short period of record are more reliable than those read directly from the charts in Australian Rainfall and Runoff (Institution of Engineers, Australia, 1977).



CANBERRA – 1932–1970, 35 COMPLETE YEARS, ANNUAL

Figure 6.6

The derived rainfall intensities are compared in Chapter VII with estimates of infiltration rates based on the field measurements.

6.3 RAINFALL INTENSITIES IN THE KYETMAUK-TAUNG CATCHMENT

Previous to the installation of a pluviograph on Mt Poppa in connection with this study there were no measurements of rainfall intensities in the vicinity of the study sites.

There were considerable difficulties associated with obtaining records from the installed pluviograph. The forestry workers stationed near the site had no previous experience with such instruments and the instrument did not always function during the monsoon season of 1977 although the charts were changed every day.

There was therefore only incomplete data for the 1977 wet season available for examination. The rainfall and corresponding durations shown in Appendix 6.6 were extracted directly from the available records. The storm events extracted are shown ranked in order of intensity in Table 6.4.

Table 6.4 Recorded rainfall intensities-durations April-November 1977 Kyetmauk-taung catchment

Ranking	Intensity (mm/hr)	Duration (mins)	Ranking	Intensity (mm/hr)	Duration (mins)
1	100	15	16	41	25
	100	15	17	40	30
3	100	6	18	40	15
4	84	5	19	40	6
5	80	5	20	30	14
6	75	8	21	24	15
7	75	4	22	24	5
8	65	12	23	25	60
9	60	6	24	21	45
	60	5	25	22	8
11	60	5	26	20	30
12	56	15	27	19	25
13	52	8	28	17	25
14	48	14	29	16	15
15	45	15	30	11	22
			31	8	15

The recorded rainfall intensities are compared in Chapter VII with estimates of infiltration rates based on the field measurements.

Discussions were held with the Department of Meteorology and Hydrology, Burma regarding rainfall intensities at Mt Poppa. The Department prepared data on predicted rainfall intensities for use in connection with this study. The data are plotted in Figures 7.2 and 7.3 to show a comparison of rainfall intensities with estimates of infiltration based on the field measurements.

CHAPTER VII

REVIEW AND SUMMARY

7.1 INTRODUCTION

It is proposed to use the Philip equation (Equation 2.2, page 18) to model the infiltration process in the deterministic hydrologic model associated with the Australian Representative Basin Model (op cit page 18). In modelling the infiltration process the recurrence of ponding and subsequently overland flow will be determined, for ponding will be synthesized in the model when rainfall intensity as modified by interception, exceeds the infiltration rate. It will be necessary in applying the model to derive values of the sorptivity (S) in the Philip Equation by experimenting with the model and to measure values in the field to check the synthesized values.

In this study, of the effect of changes in forest cover on the magnitude of infiltration rates, values of sorptivities have been obtained and the main parameter used to assess the effect of changes in forest cover, namely cumulative infiltration can be compared with rainfall in the same time period to predict the recurrence of ponding.

7.2 THE RESULTS OF STUDIES ON THE EFFECTS OF CHANGES IN FOREST COVER ON INFILTRATION

7.2.1 Change from eucalypt forest to *Pinus radiata* plantation in the Cotter catchment, Australian Capital Territory

Studies were made at sites on both granite and shale soils.

Significant differences were found between the infiltration characteristics in plots ten metres by two metres located on the same soil type and under the same forest cover. It was noted that there was considerable variability, as shown in Figures 5.4,5.5,5.6,5.7,5.8, 5.9, within the plots.

While there were some indications that infiltration characteristics on the same soil type and under the same forest cover were related to position on the slope this was not confirmed by further observations. The field measurements therefore suggest that infiltration characteristics vary randomly within the same soil and forest types and that there is considerable variability. The variability is several orders of magnitude and is shown in summary form in Table 5.8.

The field measurements comprised seven separate measurements of infiltration within each of seventeen rectangular plots, ten metres by two metres. The procedures followed Talsma (1969). The measurements provided no evidence of substantial changes in the infiltration characteristics of the upper soil layer (say 10 cm) as a result of conversion from eucalypt forest to mature *Pinus radiata* plantations.

It was concluded, and supporting Wissopakan (1977), that a random sampling procedure is the most appropriate for the investigation of infiltration characteristics of forested slopes in the Cotter catchment.

7.2.2 Changes in forest cover as a consequence of reafforestation in the Kyetmauk-taung catchment in central Burma

Studies were made using a randomized block sampling procedure in a contiguous area now covered by a mixed deciduous forest, a man made plantation and a semi-indaing forest. The mixed deciduous forest and the man made plantation were on volcanic ash and the semi-indaing forest on red loamy soils. The man made plantation was established on land originally under a mixed deciduous forest but cleared for banana plantations.

The banana plantations had been resumed as a catchment protection measure and the main purpose of the plantation establishment programme was rehabilitation of the eroding areas.

Measurements of the infiltration characteristics were made in both the dry and the wet season. The measurements made in the dry season showed that there were significant differences between the infiltration characteristics of the three forest types. The measurements made in the wet season showed that there was no significant difference between the infiltration characteristics of the mixed deciduous and the man made plantation and that there was a significant difference between the semi-indaing forest and the mixed deciduous forest and between the semi-indaing forest and the man made plantation.

It is concluded that, after a period of about 7 years since establishment, the infiltration characteristics of the man made plantation are comparable with that of the original mixed deciduous forest. This supports the conclusion of Kittredge (1948) (op cit p. 7) that 'the infiltration rates in afforestation stands may be nearly as good as in the natural stands'.

7.3 COMPARISONS OF MEASURED INFILTRATION WITH RAINFALL

7.3.1 Studies in the Cotter catchment of the Australian Capital Territory

The summarized results of the measurements of the infiltration characteristics in the Pierce's Creek forest are shown in Figure 7.1 as graphs of cumulative infiltration against time. The total rainfall is also shown plotted against time in Figure 7.1 for frequencies of occurrence

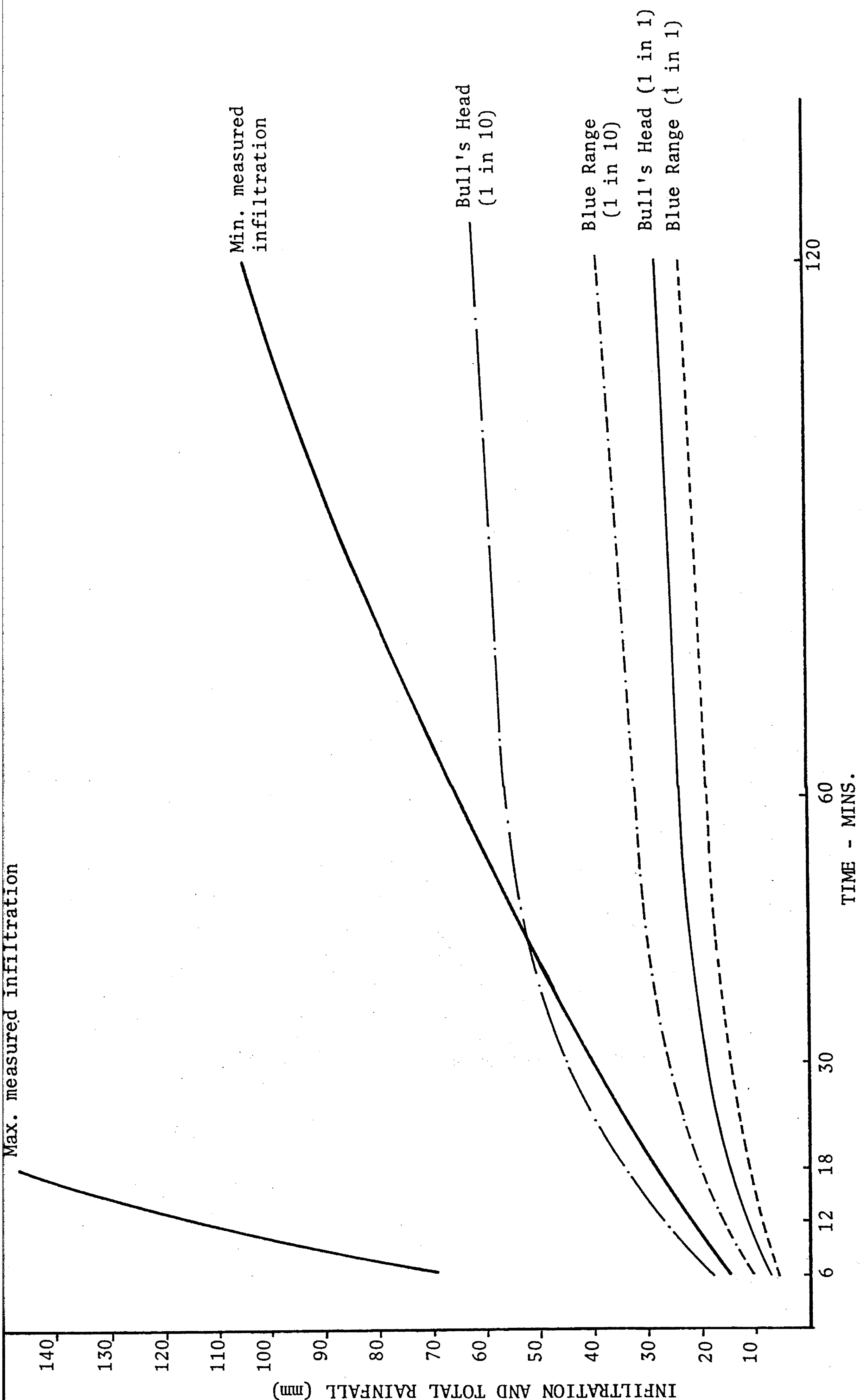


Figure 7.1 Comparison of measured infiltration with derived total rainfalls

of once in 1 year and once in ten years at the Bull's Head Station and the Blue Range Station. The rainfall data shown were derived for this study as described and presented in Chapter VI.

The time interval adopted for Figure 7.1 is 120 minutes. The time interval could be extended but as noted previously the predicted infiltrations are on the basis of measurements of the infiltration characteristics of upper soil layers, say about 10 cm. While direct measurements at lower depths were not made in this study all the indications are that the surface infiltration characteristics will be influenced by the rate of infiltration into the deeper layer of soils when water is available at the surface for longer periods. For example Hillel (1971), op cit p.15 and Figure 3.3 indicates the consequence of lower sorptivities below the upper soil profile and the measurements made in this study along the excavation for the gravity main pipeline show (as in Figure 5.4) much lower sorptivities than in the adjoining forests.

7.3.2 Studies in the Kyetmauk-taung catchment in central Burma

A summary of the results of the measurements of the infiltration characteristics in the Kyetmauk-taung catchment is shown in Figures 7.2 and 7.3, similar figures to Figure 7.1.

The total rainfall for various time intervals is also shown in Figures 7.2 and 7.3. Pluviograph data for analysis is not yet available for the study area in the Kyetmauk-taung catchment. The information shown in Figures 7.2 and 7.3 was, as indicated in Chapter VI, provided by the Department of Meteorology and Hydrology, Burma. Measured rainfall intensities during the wet season 1977 are also shown as plotted points in Figures 7.2 and 7.3. These intensities were derived from the pluviograph installed at the study area in connection with this study and as discussed in Chapter VI.

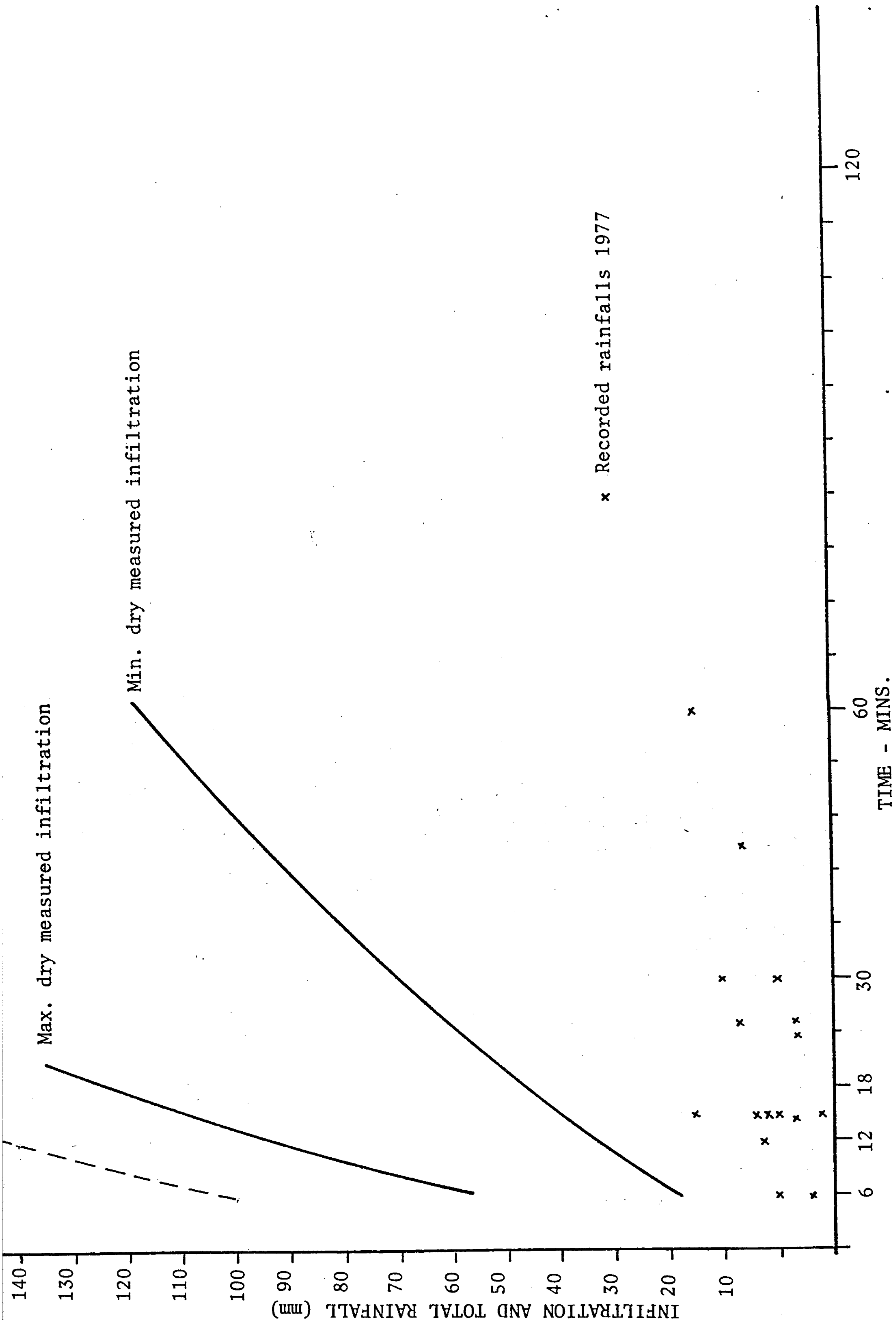


Figure 7.2 Comparison of measured infiltration (dry season) with estimated rainfall - Kyetmauk-taung catchment

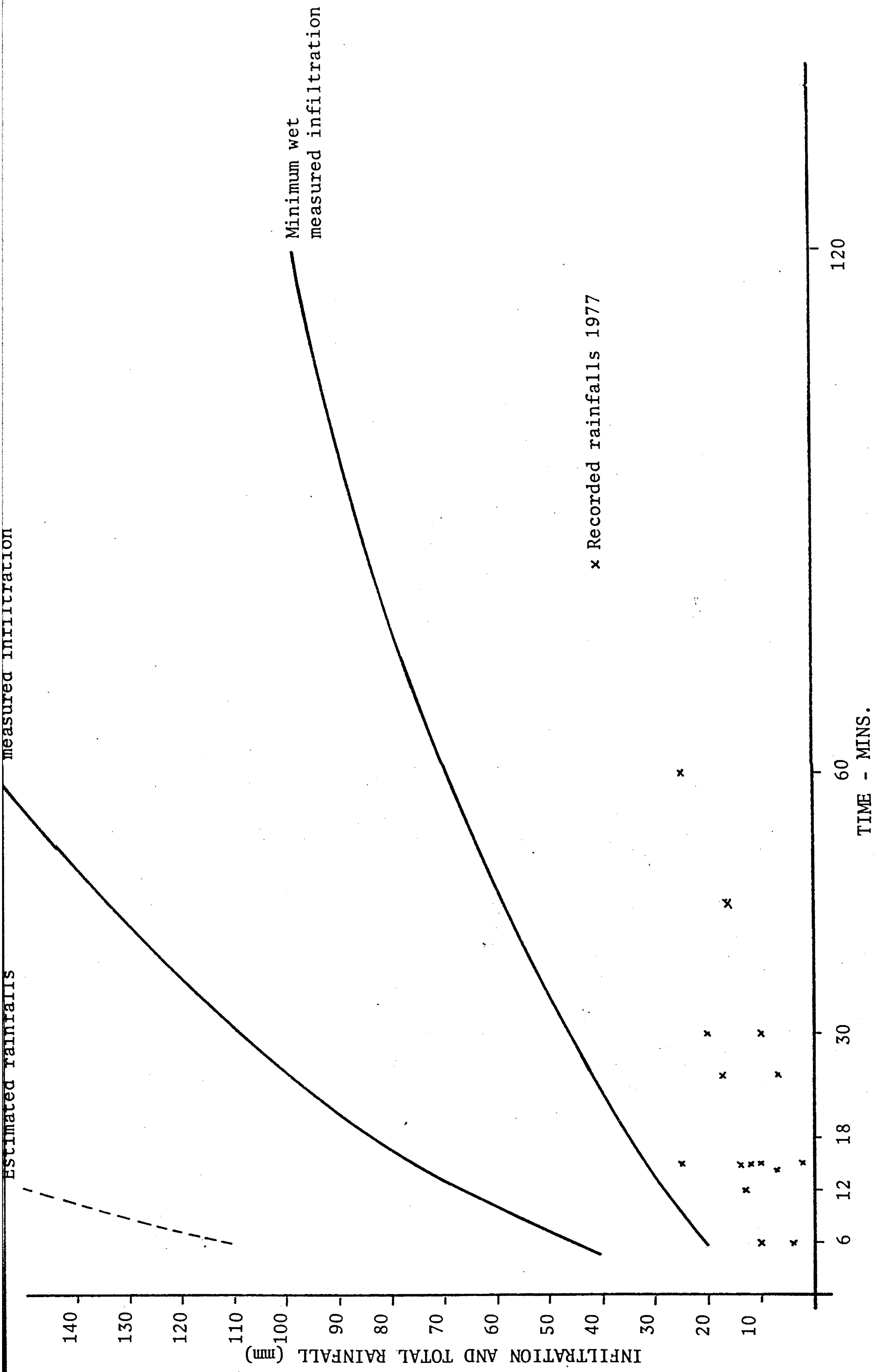


Figure 7.3 Comparison of measured infiltration (wet season) with estimated rainfall - Kyetmauk-taung catchment

7.4 THE MEASUREMENT OF SORPTIVITY AS A CATCHMENT PARAMETER

The measurements made in connection with this study have provided considerable data on the variability of sorptivity over relatively extensive areas of forest. It has been concluded, as did Wissopakan (1977) for the Orroral Representative Basin, that with the field procedures adopted for this study random sampling over the forested study area in the Cotter catchment would be appropriate. In the study area of the Kyetmauk-taung catchment random sampling within forest types would be appropriate.

All the measurements were taken in effect on a seasonal basis. The field measurements at Pierce's Creek were made in May-June 1975, the dry season measurements at Kyetmauk-taung in May 1977 and the wet season measurements in October 1977. Sorptivity is not of course a soil constant but varies with moisture content. The field measurements must therefore be considered as representative of the values occurring at the time of sampling. It was impracticable to sample simultaneously.

Soil samples were obtained to determine gravimetric moisture contents at the surface adjacent to each driven ring. Wissopakan (pers. comm.) was unable to establish any relation between measured sorptivities and gravimetric moisture in the Sawpit Creek catchment of the Orroral Representative Basin. The sampling period was May-June 1975.

The data obtained in this study were also examined for relations between sorptivity and moisture content at Pierce's Creek.

7.4.1 Measurements at Pierce's Creek in the Cotter catchment

The corresponding sorptivities and gravimetric moisture contents are shown in Figure 7.4.

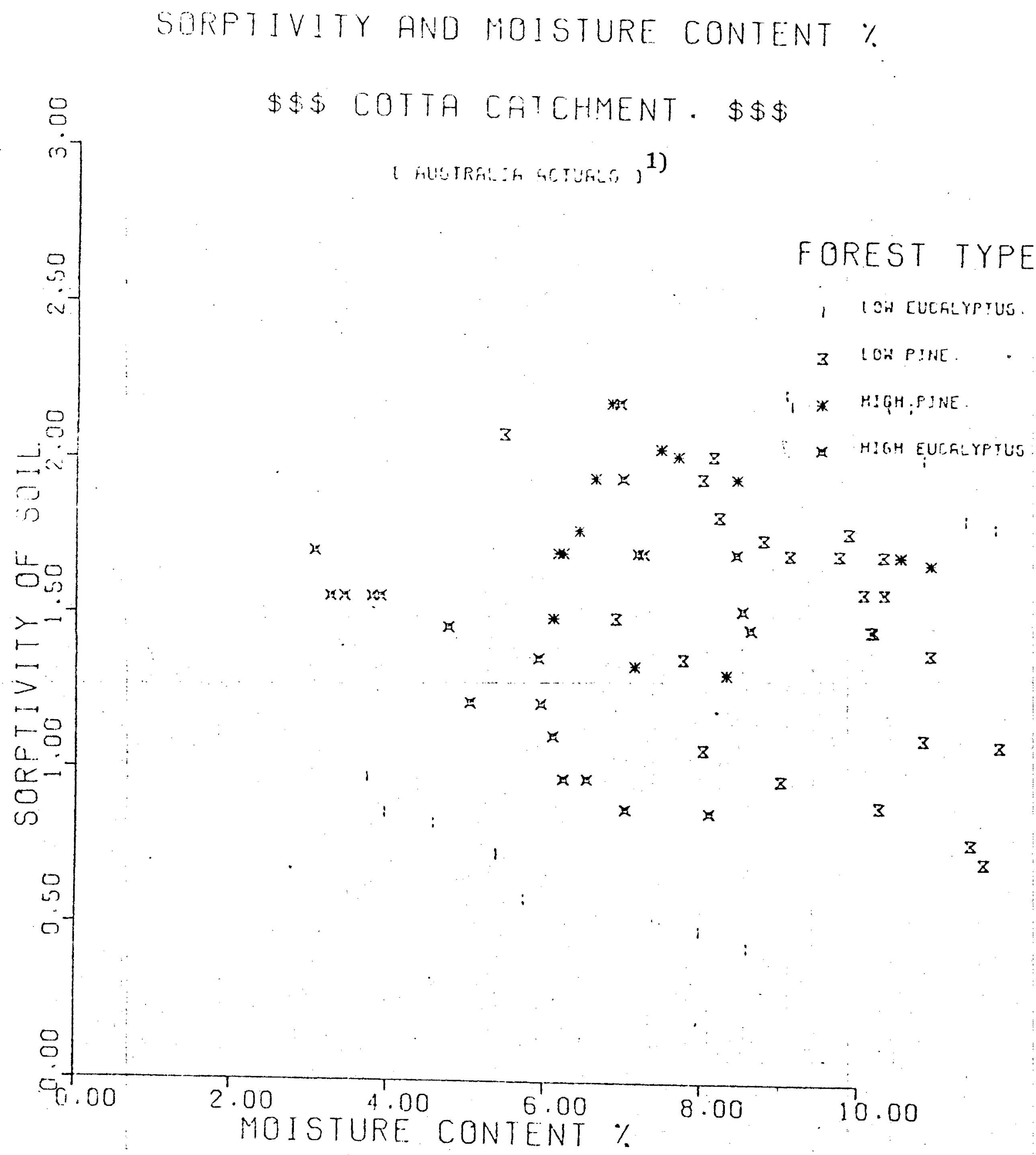


Figure 7.4

1) The data are tabulated in Appendix 5.3

Meaningful and reliable relations could not be established between the two values. The results of one regression model are shown in Appendix 7.1. Sheet 1 of that Appendix shows the regression analysis and sheet 2 the plotted regressions.

7.4.2 Measurements in the Kyetmauk-taung catchment

The corresponding sorptivities and gravimetric moisture contents are shown in Figures 7.5 and 7.6 for the dry season and wet season measurements respectively. The associated regression analyses are shown in Appendix 7.2. There is a clear relation between sorptivity and gravimetric moisture content as shown in Figures 7.7 and 7.8 respectively.

A rigorous statistical analysis to combine the data from the dry and wet season measurements could not be undertaken with the computer packages and advice available to the author in Burma. The dry season and wet season data are shown together in Figure 7.9.

It is concluded without statistical confirmation that Figure 7.9 indicates a correlation between sorptivity and gravimetric moisture content in the three forest types studied on the slopes of Mt Poppa.

It is suggested that Figure 7.9 would now provide for a convenient procedure for modelling the infiltration process in accordance with the hydrologic model of the Australian Representative Basin Programme. Field sampling of gravimetric moisture content, a relatively simple procedure compared to the field measurement of sorptivity on a catchment basis, would enable estimates to be made of the sorptivities prevailing over the catchment. This could be done within forest types on a seasonal or monthly basis in the first instance and thus estimates obtained of sorptivity on a seasonal or monthly basis.

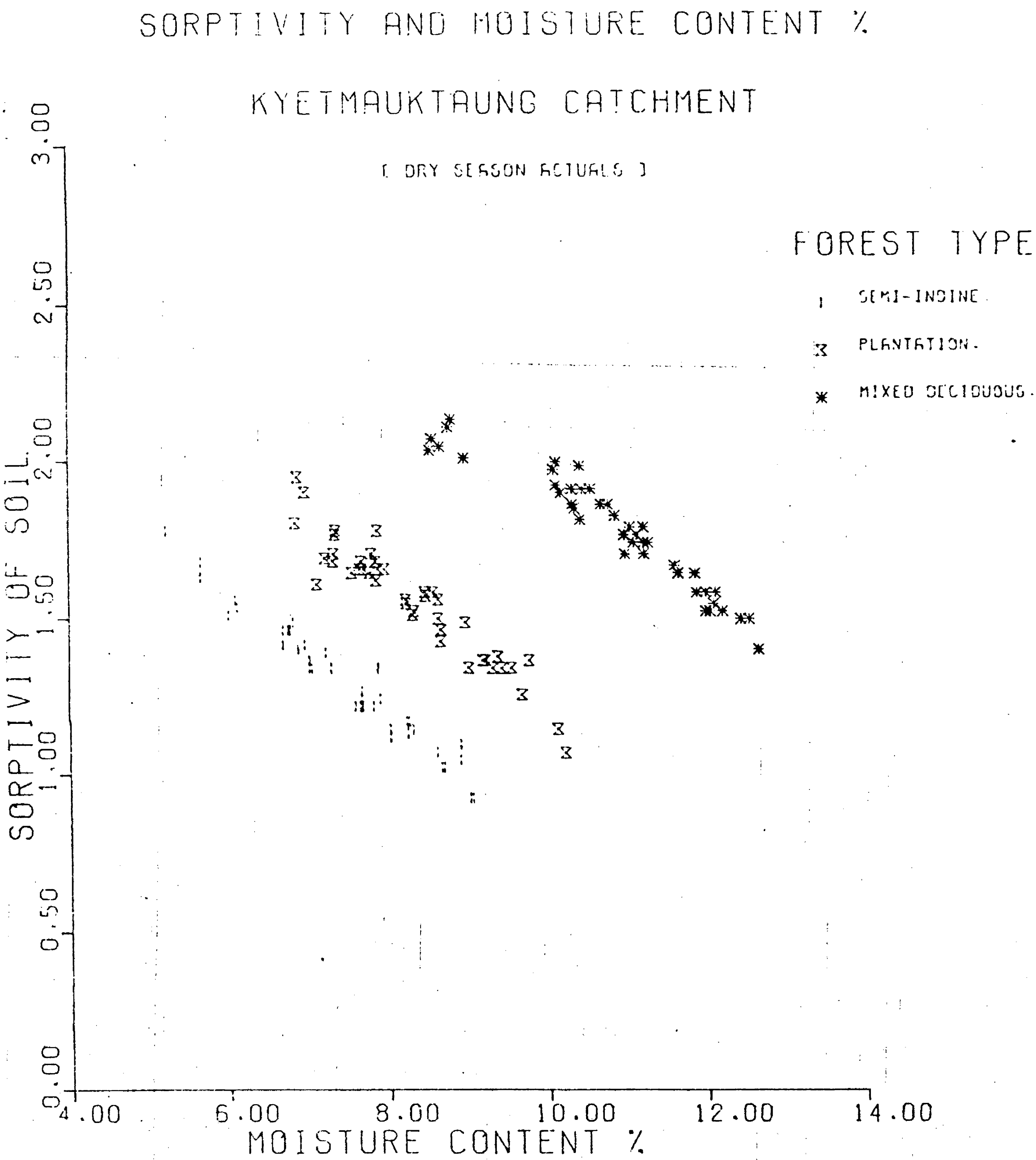

SORPTIVITY AND MOISTURE CONTENT %
KYETMAUKTAUNG CATCHMENT
[DRY SEASON ACTUALS]
FOREST TYPE
SEMI-INDINE
PLANTATION.
MIXED DECIDUOUS.
SORPTIVITY OF SOIL
0.00
0.50
1.00
1.50
2.00
2.50
3.00
4.00
6.00
8.00
10.00
12.00
14.00
MOISTURE CONTENT %

Figure 7.5

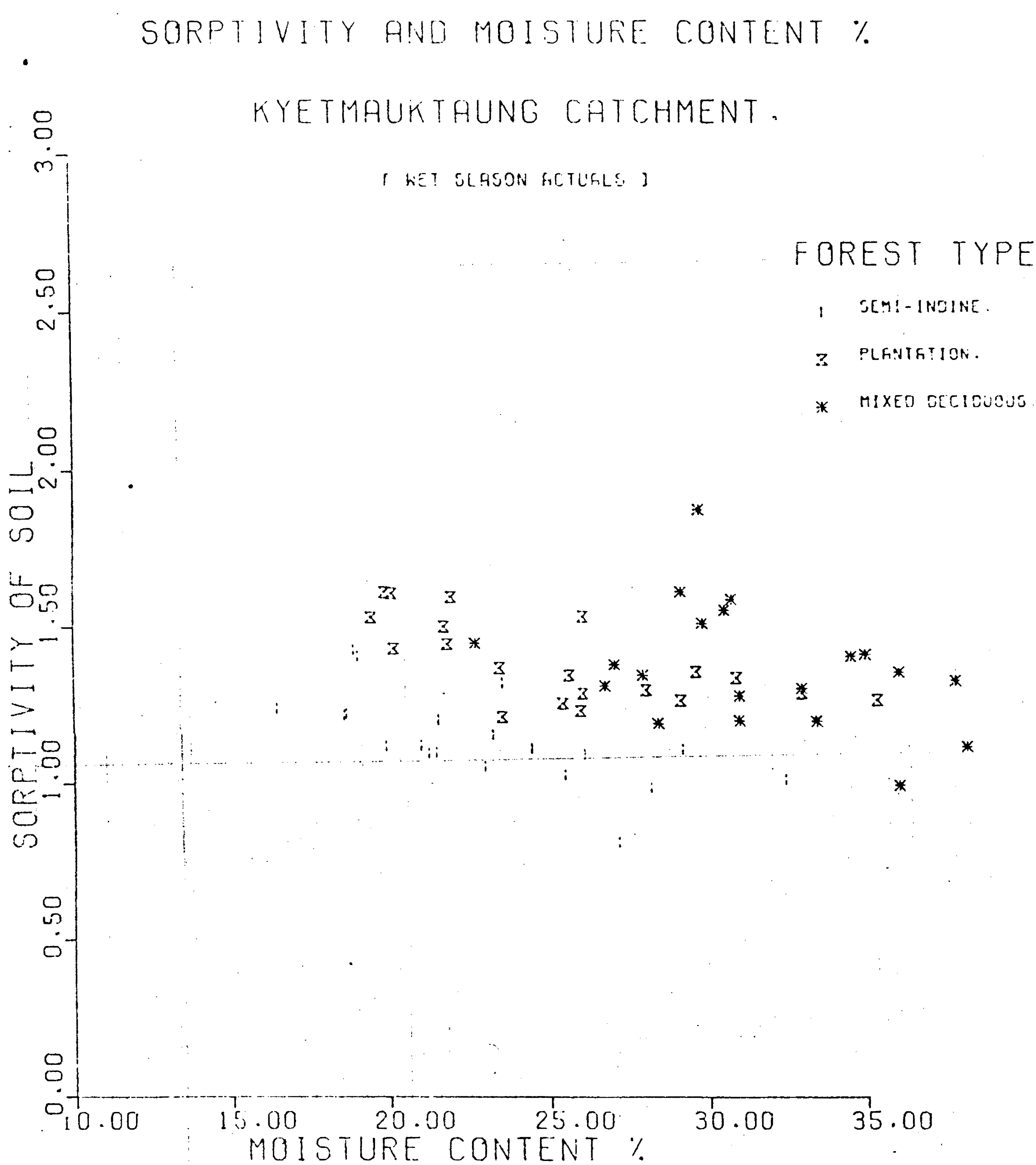
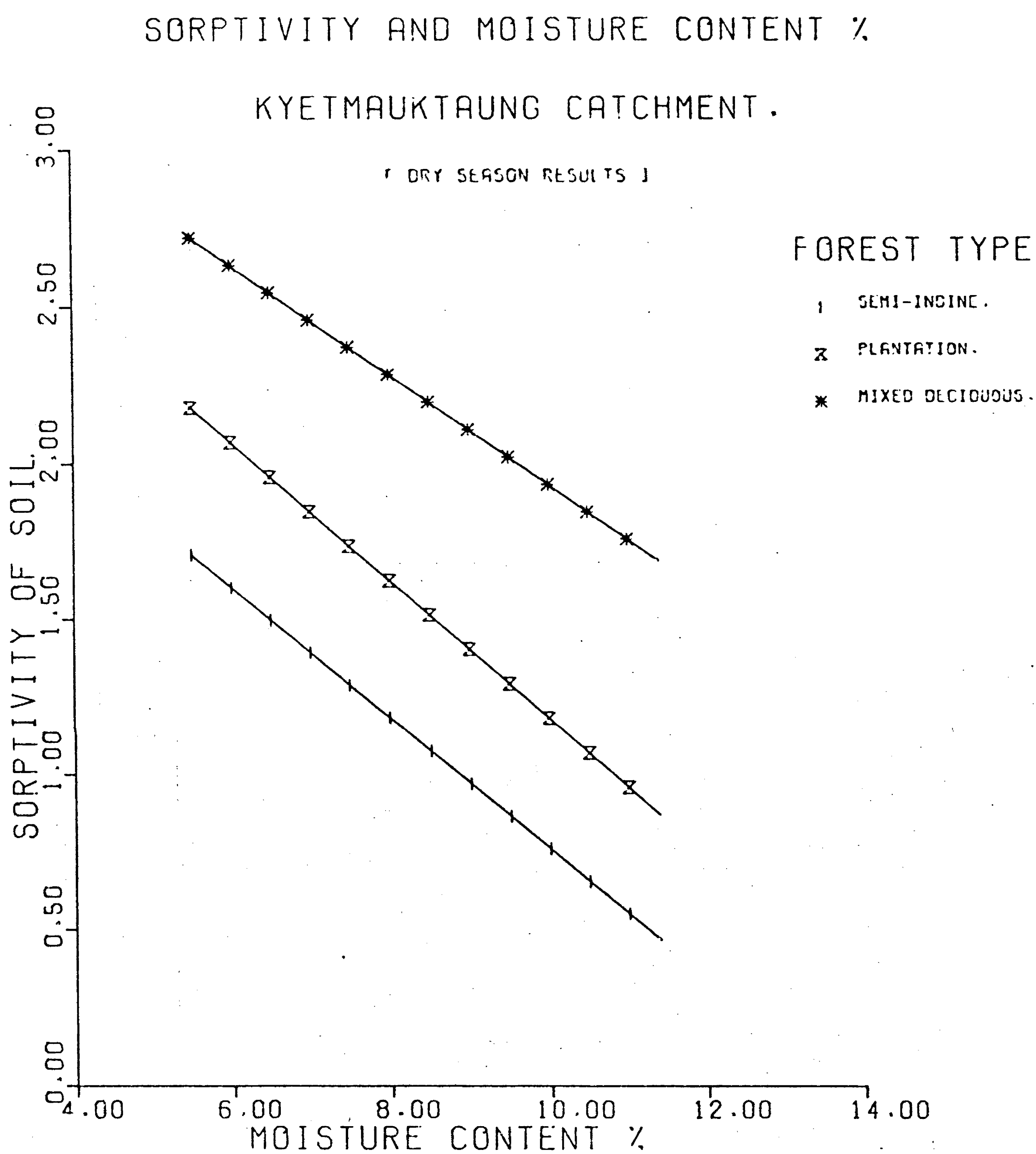

SORPTIVITY AND MOISTURE CONTENT %
KYETMAUKTAUNG CATCHMENT.
FOREST TYPE
SEMI-INDINE.
PLANTATION.
MIXED DECIDUOUS.
SORPTIVITY OF SOIL
MOISTURE CONTENT %
0.00
0.50
1.00
1.50
2.00
2.50
3.00
10.00
15.00
20.00
25.00
30.00
35.00

Figure 7.6



SORPTIVITY AND MOISTURE CONTENT %
KYETMAUKTAUNG CATCHMENT.
(DRY SEASON RESULTS)
FOREST TYPE
SEMI-INDING.
PLANTATION.
MIXED DECIDUOUS.
SORPTIVITY OF SOIL
0.00
0.50
1.00
1.50
2.00
2.50
3.00
4.00
6.00
8.00
10.00
12.00
14.00
MOISTURE CONTENT %

Figure 7.7

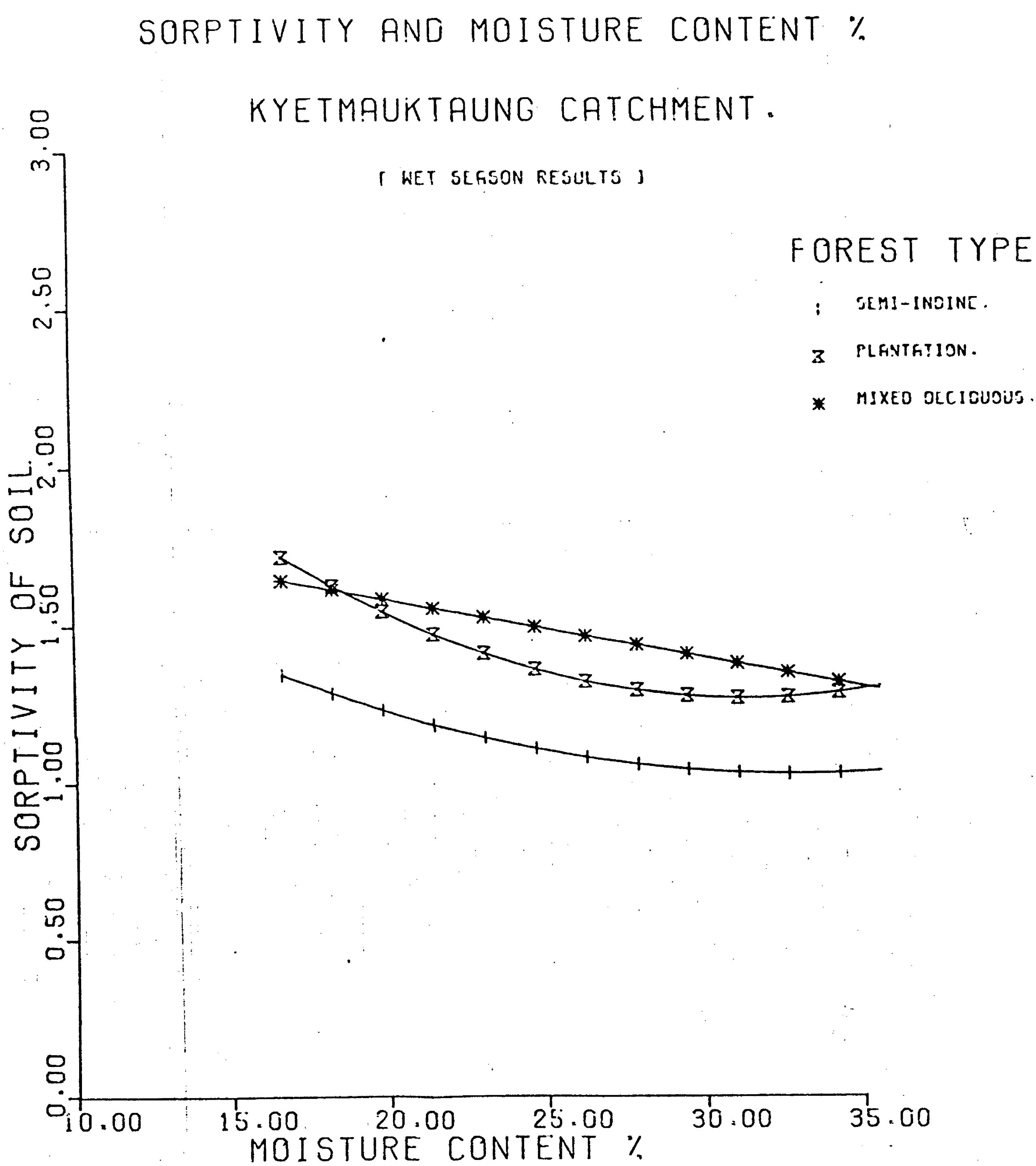
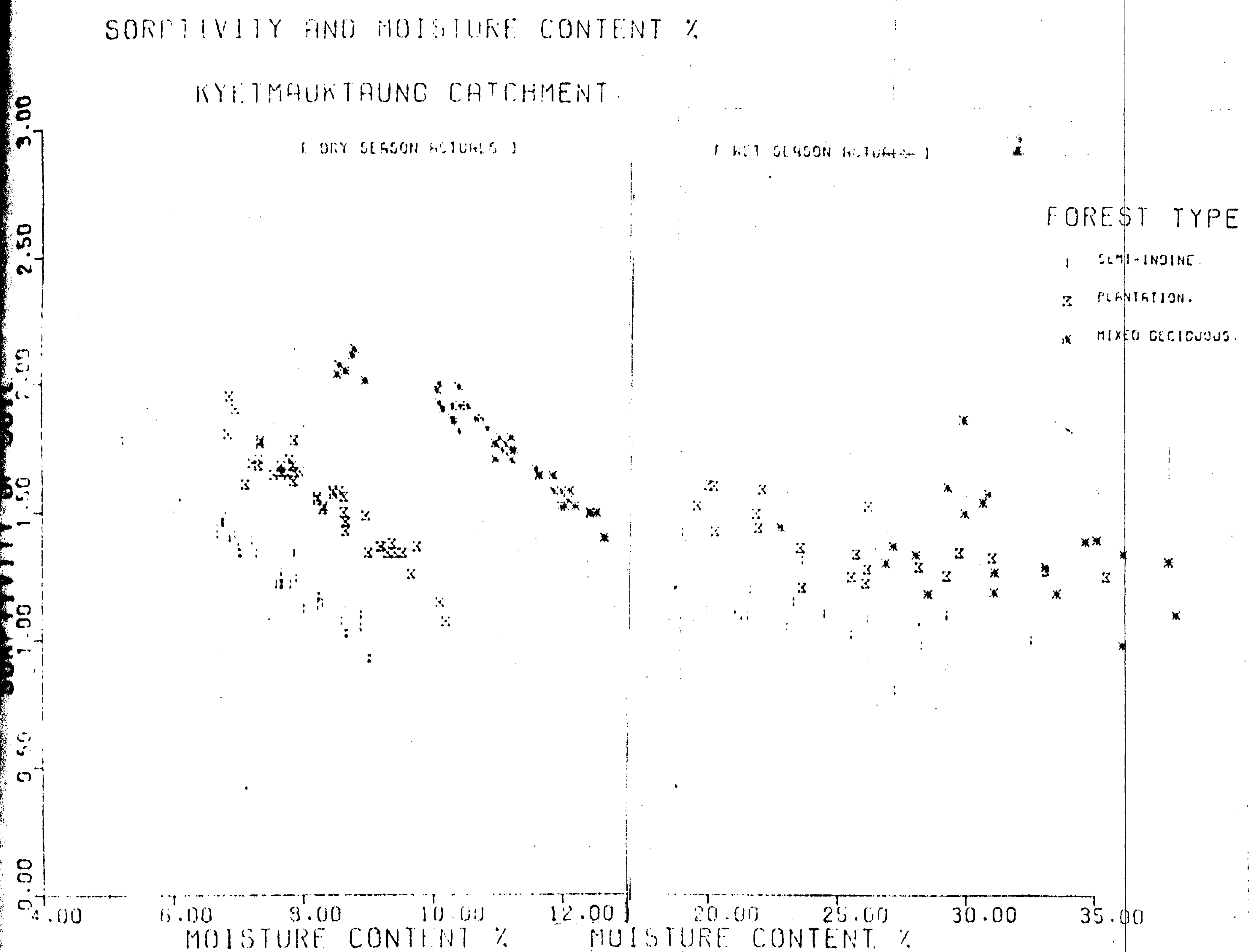

SORPTIVITY AND MOISTURE CONTENT %
KYETMAUKTAUNG CATCHMENT.
(WET SEASON RESULTS)
FOREST TYPE
SEMI-INDINE.
PLANTATION.
MIXED DECIDUOUS.
SORPTIVITY OF SOIL
0.00
0.50
1.00
1.50
2.00
2.50
3.00
10.00
15.00
20.00
25.00
30.00
35.00
MOISTURE CONTENT %

Figure 7.8



XX
XX NOTE CHANGE OF SCALE
XX
XX

Figure 7.9 Comparison of dry season and wet season relations between sorptivity and moisture content

7.4.3 Relations between sorptivities and gravimetric moisture contents in the Cotter and Kyetmauk-taung catchments

The results of the examination for relations between sorptivities derived from the field measurements and gravimetric moisture contents at the measurement site are anomalous between the two catchments under study. A good relation was found in the Kyetmauk-taung catchment but not in the Cotter.

Driving the infiltration rings in the shallow soils at the study area in Pierce's Creek was more difficult than in the deeper and more uniform soils at the Kyetmauk-taung study area. This is reflected in the greater variability in the predicted infiltration rates, and makes the determination of reliable relations more difficult. The lack of a reliable relation between sorptivity and moisture content means that at this stage the change in the sorptivities on a monthly or seasonal basis or even on the basis of particular rainfall events must in the Cotter study area be determined by measurements using the infiltration rings and the associated procedures adopted for this study.

7.5 SUMMARY

There is a very considerable field effort required to obtain realistic measurements of the very variable infiltration characteristics of forested catchments using the procedures following Talsma (1969) and adopted for this study.

The procedures do enable field measurements of infiltration characteristics (and in particular sorptivity) on a catchment basis and it is concluded that random sampling within forest types would in general be appropriate for forested catchments. In those forested areas with shallow soils where driving of infiltration rings is difficult because of, for example, stones random sampling over the whole forested area would be more appropriate.

The measurements made in the Cotter catchment of the Australian Capital Territory indicate that there has been no substantial change in infiltration characteristics of the upper layers of the granite and shale soils as a consequence of conversion from eucalypt to mature radiata pine plantations. Under both forest types and for both soils the predicted infiltration depths based on the field measurements are high relative to rainfall depths that occur in the same time period and general ponding should not occur frequently.

The measurements made in the Kyetmauk-taung catchment have shown significant differences in the infiltration characteristics of the three forest types investigated, mixed deciduous, semi-indaing and man made plantations. That the measured infiltration characteristics of the man made plantations are comparable with the values obtained for the mixed deciduous and the semi-indaing forests, generally lying between the values obtained for these two types, indicates that the plantation establishment has after only seven years resulted in infiltration characteristics of the same magnitude as pertained prior to the clearing of the forest for banana plantations. Under banana plantation cultivation the land had deteriorated to such an extent that it was eroding badly in the wet season and it had been necessary to resume the land as a catchment protection measure. It is accepted therefore that improved infiltration characteristics is one aspect of the success of the plantations in stabilizing the slopes.

The predicted infiltration depths in the Kyetmauk-taung study area are comparable with the rainfall depths predicted by the Departments of Meteorology and Hydrology, Burma.

SUMMARY OF INFILTRATION THEORIES
(after Wissopakan, 1977)

AUTHOR (reference)	DESCRIPTION AND ASSUMPTIONS	EQUATION
Green & Ampt (1911)	That the basic features of water movement in a uniform capillary tube, namely that the constant potential at the moving air-water interface, the constant conductivity, and the constant change in water content are effectively simulated by the soil water system	$i = \frac{dI}{dt} = K \times \frac{H_o - H_f}{Lf}$ i is the flux into the soil and through the transmission zone I= the cumulative infiltration K= hydraulic conductivity Ho,Hf the pressure head at the surface and wetting front respectively Lf is the length of the wetting zone
Horton (1933)	Defined the infiltration capacity as the maximum rate at which a soil can absorb precipitation and assumed that it would decrease exponentially in time from a maximum initial value to a constant rate	$Q_e = Q_f + (Q_i - Q_f)e^{-\beta t}$ where Q_e is the infiltration rate at time t cm/sec. Q_f is the initial infiltration rate cm/sec. Q_i is the final infiltration rate, cm/sec. β is a constant
Philip (1954)	Proposed sorptivity as the physical property of porous media. He showed that at small times after infiltration begins, increasing initial moisture content reduces the infiltration rate but increases the velocity of the advance of the wetting front. As time increases, the influence of initial moisture content on infiltration decreases and eventually becomes negligible, but its influence on the rate of advance of wetting front persists. He suggested that the ultimate physical explanation of the	$I = St^{\frac{1}{2}} + At + Bt^{3/2}$ where I = the cumulative infiltration t = time in minutes S = sorptivity cm/min$^{-\frac{1}{2}}$ A,B etc. are parameters associated with the second and third terms

AUTHOR (reference	DESCRIPTION AND ASSUMPTIONS	EQUATION
	effects of initial moisture content on short time infiltration must be sought in the diffusivity function and that its influence on the velocity of the wetting front is in the long term primarily a storage effect.	
Parlange (1971)	Assumed that water infiltrates into a soil because of the force due to the gradient of water pressure and the force of gravity and derived an analytic expression for the solution of the infiltration equation. The analytic solution and Philip's numerical solution are in complete numerical agreement for finite times.	$\frac{dk}{d\Theta} = \frac{\partial z}{\partial t} + \frac{\partial}{\partial \Theta}\left[\frac{D}{\frac{\partial z}{\partial \Theta}}\right]$ D is the diffusivity k is the conductivity $z(\Theta,t)$ is the position a depth of a point in a one dimensional field where the moisture concentration is Θ at time t. The following conditions are imposed on the equation at $t = 0$ $z > 0$ $\Theta = \Theta_o = 0$ at $t > 0$ $Z = 0$ $\Theta = \Theta_1^o = 1$
Farrel & Larson (1972)	Applied the Green and Ampt assumption by assuming that the soil water system is effectively simulated by a simple capillary model	$\Delta\Theta \frac{dz}{dt} = \frac{k}{z}(\psi_o - \psi_f + z)$ ψ_o is the capillary potential of soil water at the surface and z, the vertical spatial cocodinate is taken as positive in the downward direction. If the effect of gravitational potential on the movement of soil water is appreciably smaller than the effect of capillary potential and can be neglected then $\Delta\Theta . \frac{dz}{dt} = \frac{k}{z}(\psi_o - \psi_f)$

APPENDIX 3.2

THE INFILTRATION LAW OF KOSTIAKOV (1932)

Appendix 3.1 is a summary of some of the theoretical approaches to the study of infiltration, after Wissopakan (1977). Although mentioned in the text Wissopakan (op. cit.) did not include in his summary the work of Kostiakov (1932).

Kostiakov (1932) suggested an infiltration equation of the form

$$I = k.t^{\alpha}$$

where I = the total infiltration cm

k = hydraulic conductivity cm/min

t = time of infiltration, minute

α = constant

Philip (1957b) showed that for small times α has the value of $\frac{1}{2}$ and for large times α becomes unity and k assumes the value of the saturated conductivity of the soil.

While this form of expression for infiltration was widely used the disadvantage of the relation is that the parameters α and k can be varied according to the range of time.

APPENDIX 3.3

COMPARISONS OF METHODS OF INFILTRATION MEASUREMENT

Method of Computation	For $t = 10^5$ secs I (cm)	% error	For $t = 10^6$ secs I (cm)	% error
Value obtained by detailed analysis	4.477	0	18.670	0
Value obtained by extrapolation from Horton Equation (App. 3.1)	8.147	+82	29.412	+58
Kostiakov Equation (App. 3.2)	4.225	-5.6	15.395	-18
Philip Equation (Equation 1)	4.449	-0.63	17.753	-4.9

APPENDIX 4.1

MIXED DECIDUOUS FORESTS KYETMAUK-TAUNG CATCHMENT

PRINCIPAL SPECIES

Teak (*Tectona grandis*)

Pyinkado (*Xylia dolabriformis*)

Padauk (*Pterocarpus macrocarpus*)

Hnaw (*Adina cordifolia*)

Taukkyan (*Terminalia tomentosa*)

Thinwin (*Milletia* spp.)

Leza (*Lagerstoemia tomentosa*)

Ma-u-lett-an-she (*Anthocephalus cadamba*)

Thadi (*Proteum serratum*)

CHIEF BAMBOOS

Wanwe (*Oxytenanthera albo-vitiata*)

Thanawa (*Thyrostachys oliveri*)

Kyathaung (*Bambusa polymorpha*)

Myinwa (*Dendrocalamus strictus*)

Wanet (*Dendrocalamus longispathus*)

Sinthanawa (*Bambusa sinthena*)

Thaikwa (*Bambusa tulda*)

DESCRIPTION OF FIELD EQUIPMENT FOR MEASURING INFILTRATION

a) Metal infiltrometer cylinder

Twelve cylinders measuring 30 cm diameter by 15 cm high and four cylinders measuring 30 cm diameter and 25 cm high were used.

The cylinders were fabricated from smooth cold-rolled steel of 0.5 cm thickness and a sharpened cutting edge provided by grinding. The longitudinal seams were butt-welded and a reinforcing strip welded around the top. The longitudinal welds were ground to a reasonably smooth finish.

b) Constant head device

A pattern of this apparatus for the measurement of hydraulic conductivity was made available by the Pye Laboratory of the CSIRO. The circular base plate was made of perspex sheet, 1 cm thick, 29 cm in diameter, with a hole at the middle to take the stand pipe, a 5 cm diameter 100 cm long plastic tube. The base covered the infiltration ring and prevented loss of water from the top of the sample. A 1.5 cm diameter plastic tube was inserted through a rubber stopper at the end of the standpipe and held inside the 5 cm diameter tube. The inner tube acted as a bubble tube to maintain the constant hydraulic head at the lower part of the perspex sheet. The drop of water level was read from the scale on the standpipe and was converted back to volume.

c) Inclined aluminium scale

The scale which was graduated at 2 mm intervals had adjustable hooks at each end so that it could be supported across a diameter of the infiltrometer cylinder. The scale was used for reading the drop of the water level in the infiltrometer rings.

d) A steel rule

Graduated in centimetres and used for measuring the depth of soil and water in the infiltrometer ring.

e) Protractor head

Was used for adjusting the slope of the aluminium scale to the required slope (7^{o}) and for levelling the infiltrometer ring during tamping into the soil and before the measurements of hydraulic conductivity.

f) Stopwatch

A stopwatch that could be read to one second and used for timing the readings of the drop of the water level in the infiltrometer ring and in the constant head device.

g) Water containers

Water buckets and plastic drums for transporting water to the experimental sites and a small bucket to pour water into the cylinder and the constant head device.

h) Pickaxe)
)
i) Shovel)

Used for digging out with minimal disturbance the infiltrometer cylinder and the enclosed soil. The soil sample was then used to measure the hydraulic conductivity with the constant head device.

j) Driving hammer

A steel block, 10 cm in diameter, 16 cm long and weight approximately 15 kg, and attached to a 100 cm long by 2 cm diameter handle. The driving hammer was used as a tamper by dropping it on the driving plate immediately above the rim of the infiltrometer ring.

k) Driving Plate

A circular steel plate 1 cm thick cut 3 cm larger than the diameter of the measuring cylinder. A groove about 0.25 cm deep and 1.5 cm wide was ground into the lower face to position the plate on the cylinder.

n) Wire gauge

Used to support the soil in the infiltrometer cylinder while measuring the hydraulic conductivity.

FIELD MEASUREMENTS OF INFILTRATION IN FORESTS

A summary of a discussion by Wissopakan (1977)

A number of difficulties emerged in applying the Talsma method over an extensive area of forest land. Previous studies had been mostly in flat agricultural land.

In total the equipment necessary is quite heavy and it was not possible to carry all of it at one time to some of the sites which in the hilly forested areas were some distance from the vehicle access. Water had also to be carried for some distance to some of the sites. At least 15 litres of water was required at each site and in practice about 18 litres were carried.

Driving the cylinder into the ground without disturbance proved difficult at some sites and obstructions were met that prevented penetration with the infiltration ring. On these occasions the ring was shifted a few metres and driving recommenced.

The extraction of the infiltration rings to provide an undisturbed sample for the measurement of hydraulic conductivity proved the most difficult aspect of the technique. Disturbance during extraction could readily cause channels for the passage of water and increase the measured hydraulic conductivity. Disturbance at the top of the sample where it met the ring was the most common problem. This sometimes occurred during driving of the cylinder. The soil at the circumference of the top of the sample, that is adjacent to the ring, was always lightly tamped before measuring for hydraulic conductivity.

Many measurements were taken on sloping ground and it was necessary to have infiltration rings with a range of depths to ensure the scale could be placed in position and water could be ponded on the soil when the bottom of the ring had penetrated to a depth of 10 cm.

There were practical difficulties in recording some of the readings. Where the sorptivity and hydraulic conductivities were high the water levels changed rapidly and it would have been desirable for the field party to have been three.

In ponding the water in the cylinder for the measurement of sorptivity it was desirable to begin with a constant depth of water as the depth has a small effect on sorptivity (Philip, 1958). This was not always accurately achieved and the readings at different sites may be slightly higher or lower. Philip (1958) suggested that a 1 cm change in the depths of water would change sorptivity by 2%. In the techniques used it is not feasible to measure the actual depth of water as readings must be taken immediately the water has been ponded. The actual average depths of water were within a range of about ± 1 cm.

In the case of hydraulic conductivity the height from the bottom of the soil sample to the lower part of the perspex sheet of the constant head device was determined by measurement and average height applied to the Darcy equation to calculate the hydraulic conductivity.

LOWER COTTER CATCHMENT

PIERCE'S CREEK AREA

Results of field measurements of soil moisture content, sorptivity, hydraulic conductivity and infiltration

Site & sample No.		Gravimetric moisture content (%)	Sorptivity cm $min^{-\frac{1}{2}}$ (S)	Hydraulic conductivity cm $min.^{-1}$ (K)	Infiltration (1 min.) cumulative (cm)	Infiltration (1 min.) Rate cm $min.^{-1}$
1A	5	6.98	1.95	0.120	1.99	1.02
	7	7.18	1.71	0.230	1.79	0.935
	8	8.62	1.46	0.153	1.52	0.786
	10	6.94	2.19	0.234	2.28	1.18
	11	8.52	1.52	0.210	1.60	0.837
	12	8.44	1.71	0.205	1.78	0.926
	16	7.25	1.71	0.140	1.76	0.903
1B	1	11.0	0.400	0.0037	0.401	0.201
	5	10.4	0.436	0.0073	0.439	0.221
	9	14.8	0.105	0.0031	0.106	0.053
	10	13.2	0.278	0.0055	0.280	0.141
	11	11.6	0.375	0.0069	0.378	0.190
	16	12.3	0.375	0.0132	0.380	0.192
	18	14.1	0.243	0.0147	0.249	0.127
1C	3	9.12	2.19	0.271	2.29	1.19
	6	11.3	1.83	0.242	1.91	1.00
	8	10.3	2.19	0.209	2.27	1.17
	13	9.05	2.23	0.217	2.31	1.19
	15	10.8	2.02	0.316	2.14	1.12
	16	10.6	2.19	0.229	2.28	1.18
	17	11.7	1.80	0.363	1.93	1.03
2A	6	8.10	0.868	0.270	0.964	0.530
	7	6.10	1.11	0.470	1.28	0.725
	9	5.91	1.36	0.203	1.44	0.755
	10	5.94	1.22	0.375	1.35	0.743
	11	7.03	0.878	0.326	0.994	0.555
	15	6.53	0.975	0.280	1.07	0.587
	16	6.23	0.975	0.289	1.08	0.591

Site & sample No.		Gravimetric moisture content (%)	Sorptivity cm min.$^{-\frac{1}{2}}$ (S)	Hydraulic conductivity cm min.-1 (K)	Infiltration (1 min.) cumulative (cm)	Rate cm min.$^{-1}$
2C	2	8.14	2.02	0.502	2.20	1.19
	4	9.74	1.71	0.309	1.82	0.96
	6	10.2	1.46	0.385	1.60	0.869
	9	8.78	1.75	0.539	1.95	1.07
	12	9.12	1.71	0.265	1.80	0.948
	16	10.9	1.39	0.316	1.50	0.808
	18	10.1	1.58	0.414	1.73	0.940
3A	2	15.0	1.30	0.206	1.37	0.723
	3	17.1	1.11	0.118	1.16	0.599
	4	13.1	1.34	0.426	1.49	0.822
	6	19.4	0.975	0.180	1.04	0.552
	11	12.5	1.46	0.373	1.60	0.865
	14	17.1	1.07	0.114	1.11	0.577
	16	17.9	0.975	0.369	1.11	0.619
3B	1	10.8	0.256	0.181	0.321	0.193
	6	10.8	0.375	0.151	0.429	0.242
	8	10.6	0.390	0.0976	0.425	0.230
	9	9.02	0.509	0.108	0.548	0.293
	10	10.8	0.375	0.126	0.420	0.233
	11	12.1	0.244	0.111	0.283	0.162
	17	11.4	0.244	0.106	0.282	0.160
3C	2	15.6	1.07	0.302	1.180	0.644
	5	35.6	0.878	0.258	0.970	0.531
	6	21.8	0.895	0.402	1.040	0.591
	9	19.7	0.975	0.337	1.105	0.608
	15	19.7	1.50	0.232	1.58	0.833
	17	14.4	1.46	0.448	1.62	0.891
	18	14.5	1.10	0.448	1.26	0.709
4A	3	7.69	2.02	0.736	2.29	1.274
	4	10.9	1.68	0.402	1.83	0.985
	9	10.5	1.71	0.431	1.86	1.01
	12	10.5	1.71	0.416	1.85	1.00
	14	7.46	2.05	0.825	2.34	1.32
	15	8.44	1.95	0.934	2.28	1.01
	16	6.84	2.19	0.477	2.36	1.27

Site & sample No.		Gravimetric moisture content (%)	Sorptivity cm min.$^{-\frac{1}{2}}$ (S)	Hydraulic conductivity cm min.$^{-1}$ (K)	Infiltration (1 min.) cumulative (cm)	Infiltration (1 min.) Rate cm min.$^{-1}$
4C	1	9.86	1.78	1.13	2.18	1.30
	2	8.22	1.83	0.954	2.17	1.25
	3	10.3	1.71	0.842	2.01	1.15
	5	5.47	2.09	0.729	2.35	1.31
	8	13.3	1.51	0.460	1.68	0.920
	15	8.00	1.95	0.566	2.15	1.18
	18	10.3	1.58	0.715	1.84	1.05
5A	3	6.16	1.71	0.442	1.86	1.01
	4	6.43	1.78	0.421	1.93	1.04
	7	6.22	1.71	0.604	1.92	1.07
	8	6.10	1.49	0.505	1.68	0.928
	10	7.14	1.34	0.504	1.52	0.850
	17	8.32	1.32	0.494	1.49	0.835
	18	6.63	1.95	0.503	2.13	1.16
5B	1	14.1	0.122	0.0062	0.124	0.063
	2	13.0	0.133	0.0053	0.135	0.068
	3	13.6	0.127	0.0059	0.129	0.066
	5	12.7	0.141	0.0038	0.141	0.072
	8	12.3	0.163	0.0049	0.164	0.083
	15	13.0	0.127	0.0036	0.129	0.065
	17	12.3	0.146	0.0057	0.148	0.075
5C	1	11.6	0.718	0.218	0.796	0.437
	3	12.9	0.731	0.276	0.830	0.464
	5	7.76	1.36	0.549	1.56	0.878
	6	10.3	0.894	0.697	1.14	0.696
	11	11.4	0.780	0.743	1.05	0.655
	14	8.02	1.07	0.410	1.22	0.683
	15	9.01	0.975	0.661	1.21	0.724
6B	1	9.18	0.366	0.095	0.400	0.217
	2	8.11	0.366	0.091	0.398	0.215
	3	13.1	0.244	0.078	0.272	0.150
	10	9.68	0.279	0.069	0.303	0.164
	11	7.83	0.390	0.054	0.409	0.214
	13	10.1	0.244	0.078	0.272	0.150
	16	9.86	0.348	0.100	0.384	0.210

Site & sample No.		Gravimetric moisture content (%)	Sorptivity cm min.$^{-1/2}$ (S)	Hydraulic conductivity cm min.$^{-1}$ (K)	Infiltration (1 min.) cumulative (cm)	Infiltration (1 min.) Rate cm min.$^{-1}$
6C	1	13.7	0.975	0.257	1.07	0.579
	5	14.6	0.895	0.251	0.984	0.537
	7	10.1	1.46	0.426	1.61	0.883
	8	10.8	1.11	0.544	1.31	0.751
	11	6.90	1.49	0.487	1.67	0.921
	16	12.8	0.975	0.491	1.15	0.663
	17	11.8	1.10	0.371	1.23	0.681
7A	1	5.04	1.22	0.952	1.56	0.949
	2	4.77	1.46	0.793	1.75	1.01
	5	3.79	1.56	0.833	1.86	1.08
	6	3.91	1.56	0.823	1.85	1.07
	8	3.06	1.71	1.02	2.07	1.22
	10	3.44	1.56	0.750	1.83	1.05
	12	3.26	1.56	0.609	1.78	0.998
7C	2	8.58	0.439	0.178	0.502	0.283
	5	4.58	0.839	0.183	0.894	0.480
	10	7.97	0.488	0.119	0.530	0.286
	11	5.39	0.731	0.304	0.840	0.474
	13	3.73	0.975	0.441	1.13	0.645
	16	3.96	0.862	0.318	0.981	0.545
	18	5.74	0.585	0.391	0.725	0.432

COTTER CATCHMENT, PIERCE'S CREEK AREA
####8 TEMPERATE FOREST ####
AUSTRALIA.

DATE ! 05/04/78
TIME ! 17/22/56

CUMULATIVE INFILTRATION.

BLOCK = I

PLOT NO	TIME(MINS) 1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
1A5	1,993	5,034	7,271	9,047	11,970	17,684	26,520	33,901	52,477	83,281	135,914	228,485	313,921
1A7	1,788	4,673	6,898	8,720	11,814	18,154	28,566	37,705	62,001	105,038	183,258	328,588	467,679
1A8	1,517	3,911	5,724	7,191	9,654	14,616	22,596	29,484	47,475	78,696	134,406	236,305	332,855
1A10	2,277	5,875	8,602	10,811	14,523	22,008	34,062	44,478	71,717	119,052	203,625	358,489	505,330
1A11	1,599	4,182	6,178	7,815	10,597	16,306	25,700	33,957	55,940	94,949	165,953	298,042	424,560
1A12	1,780	4,619	6,790	8,558	11,544	17,614	27,486	36,085	58,761	98,558	170,298	302,668	428,799
1A16	1,756	4,479	6,510	8,139	10,845	16,216	24,690	31,891	50,373	81,782	136,746	235,564	328,143
1B 1	0,401	0,987	1,400	1,719	2,228	3,174	4,534	5,597	8,052	11,661	17,040	25,194	31,887
1B 5	0,439	1,084	1,543	1,898	2,468	3,536	5,091	6,322	9,214	13,579	20,500	30,902	39,909
1B 9	0,106	0,263	0,376	0,464	0,607	0,878	1,280	1,604	2,384	3,604	5,561	8,792	11,640
1B10	0,280	0,692	0,985	1,213	1,579	2,267	3,272	4,070	5,957	8,825	13,282	20,386	26,473
1B11	0,378	0,934	1,329	1,636	2,128	3,052	4,400	5,469	7,987	11,801	17,701	27,058	35,042
1B16	0,380	0,947	1,355	1,676	2,195	3,187	4,672	5,877	8,807	13,446	20,998	33,661	44,952
1B18	0,249	0,628	0,907	1,128	1,491	2,200	3,294	4,206	6,496	10,283	16,756	28,054	38,482
1C 3	2,290	5,954	8,760	11,049	14,919	22,800	35,646	46,854	76,469	128,556	222,633	396,505	562,554
1C 6	1,914	4,995	7,368	9,309	12,601	19,338	30,581	40,059	65,752	111,186	193,640	346,645	492,964
1C 8	2,268	5,820	8,493	10,648	14,250	21,462	32,970	42,840	68,441	112,500	190,521	332,281	466,018
1C13	2,305	5,923	8,649	10,849	14,530	21,912	33,716	43,857	70,206	115,650	196,283	343,044	481,658
1C15	2,136	5,632	8,361	10,613	14,464	22,438	35,697	47,445	78,992	135,499	239,199	433,430	620,261
1C16	2,275	5,865	8,582	10,781	14,472	21,906	33,858	44,172	71,105	117,828	201,177	353,593	497,986
1C17	1,933	5,196	7,803	9,985	13,767	21,747	35,511	47,527	80,879	141,710	255,070	470,045	678,423
2A 6	0,964	2,703	4,161	5,415	7,642	12,499	21,061	28,975	51,131	92,619	171,599	323,910	473,047
2A 7	1,282	3,736	5,873	7,748	11,138	18,702	32,550	45,167	81,579	150,777	284,046	543,330	798,541
2A 9	1,437	3,777	5,596	7,092	9,645	14,910	23,628	31,326	51,925	88,680	155,906	281,472	402,046
2A10	1,353	3,789	5,829	7,581	10,692	17,474	29,418	40,453	71,327	129,109	259,062	451,034	658,549
2A11	0,994	2,848	4,437	5,818	8,298	13,781	23,581	32,725	58,553	107,354	200,915	382,324	560,523
2A15	1,075	2,987	4,575	5,933	8,334	13,540	22,657	31,045	54,427	98,018	180,711	339,748	495,220
2A16	1,078	3,008	4,617	5,996	8,439	13,750	23,077	31,675	55,687	100,538	185,751	349,828	510,340
2C 2	2,202	6,031	9,158	11,808	16,456	26,422	43,065	59,397	102,896	183,307	334,815	624,662	907,109
2C 4	1,817	4,841	7,234	9,224	12,654	19,834	31,926	42,745	72,081	125,198	225,578	409,228	588,639
2C 6	1,600	4,407	6,716	8,679	12,135	19,578	32,520	44,370	77,247	138,240	253,494	474,481	690,119
2C 9	1,948	5,455	8,392	10,914	15,393	25,155	42,548	58,230	102,669	185,833	344,082	649,154	947,808
2C12	1,801	4,747	7,046	8,942	12,183	18,892	30,042	39,919	66,429	113,894	200,970	364,012	520,815
2C16	1,502	4,081	6,169	7,928	11,000	17,541	28,779	38,979	67,040	118,639	215,440	399,998	579,474
2C18	1,732	4,769	7,264	9,386	13,118	21,152	35,115	47,896	83,340	149,071	275,240	511,262	743,491

CUMULATIVE INFILTRATION.

COTTER CATCHMENT, PIERCE'S CREEK AREA
#####8 TEMPERATE FOREST ####
AUSTRALIA.

DATE : 05/04/78
TIME : 17/23/46

BLOCK - I

TIME(MINS)

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
3A 2	1.373	3.623	5.382	6.835	9.320	14.473	23.051	30.659	51.109	87.779	155.157	281.397	402.906
3A 3	1.156	2.982	4.366	5.487	7.370	11.166	17.278	22.559	36.365	60.545	105.182	181.602	255.949
3A 4	1.493	4.196	6.469	8.425	11.906	19.510	32.958	45.364	80.192	145.484	209.896	509.992	745.185
3A 6	1.059	2.775	4.150	5.296	7.272	11.416	18.409	24.673	41.083	72.550	129.755	237.796	342.292
3A11	1.596	4.383	6.667	8.606	12.012	19.332	32.028	43.632	75.771	135.288	247.590	462.675	672.407
3A14	1.113	2.872	4.205	5.284	7.098	10.755	16.044	21.732	35.055	58.152	99.447	175.055	246.741
3A16	1.107	3.178	4.958	6.507	9.291	15.454	26.485	36.787	65.911	120.986	226.047	431.620	653.028
3B 1	0.521	1.015	1.663	2.250	3.343	5.864	10.507	15.079	28.147	53.451	102.879	200.069	296.523
3B 6	0.429	1.243	1.947	2.563	3.673	6.142	10.580	14.739	26.527	48.881	91.861	175.578	257.522
3B 8	0.425	1.164	1.769	2.281	3.180	5.109	8.448	11.496	19.928	35.521	64.911	121.154	175.969
3B 9	0.548	1.479	2.228	2.856	3.948	6.262	10.212	13.782	23.561	41.461	74.914	158.505	200.253
3B10	0.420	1.189	1.839	2.401	3.404	5.605	9.508	13.131	23.515	42.462	79.050	149.725	219.048
3B11	0.283	0.835	1.321	1.749	2.526	4.270	7.454	10.416	18.916	35.123	66.416	127.414	187.522
3B17	0.282	0.824	1.297	1.716	2.472	4.162	7.218	10.092	18.268	33.827	65.024	122.230	179.746
3C 2	1.181	3.275	5.012	6.496	9.117	14.793	24.720	33.846	59.263	106.608	196.559	368.879	557.477
3C 5	0.970	2.702	4.145	5.381	7.569	12.323	20.665	28.351	49.805	89.858	165.925	312.340	455.547
3C 6	1.038	3.054	4.824	6.382	9.211	15.552	27.045	37.870	68.708	127.471	240.879	461.871	679.590
3C 9	1.095	3.111	4.822	6.304	8.952	14.776	25.129	34.753	61.843	112.850	210.575	399.076	584.212
3C15	1.583	4.171	6.191	7.856	10.702	16.592	26.379	35.045	58.505	99.955	176.293	319.245	456.711
3C17	1.622	4.542	6.985	9.083	12.807	20.922	35.208	48.402	85.511	154.568	285.750	538.995	786.887
3C18	1.257	3.647	5.721	7.535	10.810	18.102	31.227	43.533	78.446	144.702	272.165	519.948	763.721
4A 3	2.286	6.552	10.161	13.313	18.964	31.438	53.097	74.445	132.992	243.499	455.199	865.450	1208.261
4A 4	1.825	4.981	7.549	9.720	13.520	21.643	35.055	48.412	83.606	148.519	270.604	503.825	750.891
4A 9	1.860	5.103	7.758	10.011	13.965	22.456	37.170	50.611	87.813	156.662	286.506	535.084	777.423
4A12	1.855	5.070	7.691	9.910	13.797	22.120	36.498	49.603	85.797	152.650	278.442	518.956	753.251
4A14	2.342	6.783	10.628	13.989	20.052	33.535	57.780	80.497	144.905	267.050	501.917	958.325	1407.241
4A15	2.284	6.779	10.759	14.280	20.692	35.127	61.405	86.228	157.151	292.588	554.525	1065.704	1569.751
4A16	2.564	6.596	9.645	12.376	17.130	27.222	44.490	60.120	103.001	181.620	328.761	608.761	880.758
4C 1	2.184	6.789	11.025	14.841	21.899	38.088	68.105	96.790	179.596	339.416	650.064	1262.175	1866.980
4C 2	2.168	6.520	10.419	13.886	20.231	34.600	60.910	85.856	157.555	294.400	560.082	1079.551	1592.559
4C 3	2.007	5.983	9.518	12.650	18.363	31.252	54.762	76.999	140.589	262.214	497.010	957.292	1410.755
4C 5	2.549	6.679	10.362	13.551	19.256	31.810	54.142	74.914	133.412	243.608	454.584	862.537	1262.650
4C 8	1.676	4.688	7.208	9.371	13.209	21.570	36.282	49.867	87.857	158.918	294.082	554.572	809.554
4C15	2.152	5.989	9.180	11.911	16.743	27.230	45.012	62.539	109.755	197.853	365.018	686.691	1001.253
4C18	1.840	5.413	8.553	11.319	16.340	27.596	48.003	67.228	122.004	226.599	427.096	820.574	1207.459

CUMULATIVE INFILTRATION,

COTTER CATCHMENT, PIERCE'S CREEK AREA
#####8 TEMPERATE FOREST ####
AUSTRALIA,

DATE : 03/04/78
TIME : 17/23/59

BLOCK - I

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	300.	720.	1440.	2880.	4320.
	TIME(MINS)												
5A 3	1.864	5.127	7.805	10.081	14.082	22.690	37.058	51.313	89.217	159.470	292.122	546.316	794.271
5A 4	1.930	5.260	7.967	10.254	14.255	22.800	37.527	50.926	87.868	155.960	285.952	528.351	766.244
5A 7	1.922	5.473	8.498	11.120	15.813	26.152	44.562	61.699	109.989	201.014	375.210	712.492	1043.555
5A 8	1.675	4.744	7.342	9.588	13.597	22.397	38.012	52.510	93.272	169.928	316.559	599.489	877.151
5A10	1.520	4.363	6.803	8.926	12.740	21.178	36.274	50.368	90.200	165.500	309.928	590.056	865.281
5A17	1.493	4.283	6.677	8.761	12.504	20.785	35.598	49.429	88.513	162.597	304.106	578.955	848.989
5A18	2.150	5.855	8.912	11.509	16.074	25.892	42.950	58.525	101.725	181.777	352.906	622.467	904.897
5B 1	0.124	0.312	0.448	0.556	0.733	1.075	1.598	2.030	3.105	4.852	7.790	12.872	17.510
5B 2	0.135	0.357	0.483	0.598	0.785	1.143	1.684	2.125	3.206	4.954	7.779	12.604	16.943
5B 3	0.129	0.324	0.466	0.577	0.760	1.111	1.645	2.085	3.169	4.925	7.651	12.874	17.452
5B 5	0.142	0.353	0.504	0.622	0.813	1.174	1.709	2.140	3.174	4.783	7.555	11.585	15.296
5B 8	0.164	0.409	0.585	0.722	0.944	1.367	1.996	2.504	3.751	5.656	8.758	13.905	18.457
5B15	0.129	0.319	0.456	0.563	0.736	1.063	1.549	1.941	2.881	4.549	6.699	10.570	13.976
5B17	0.148	0.371	0.532	0.658	0.864	1.258	1.854	2.339	3.550	5.455	8.572	13.894	18.681
5C 1	0.796	2.227	3.423	4.450	6.272	10.239	17.218	23.660	41.675	75.565	139.457	262.905	383.746
5C 3	0.830	2.583	3.717	4.879	6.966	11.586	19.854	27.576	49.406	90.684	169.675	323.496	474.443
5C 5	1.561	4.519	7.080	9.319	13.356	22.332	38.472	53.592	96.457	177.744	334.054	637.728	956.430
5C 6	1.142	3.682	6.082	8.271	12.361	21.855	39.656	56.790	106.557	203.183	392.522	764.782	1153.975
5C11	1.045	3.502	5.885	8.084	12.231	21.959	40.379	58.217	110.506	211.943	411.027	805.918	1197.556
5C14	1.219	3.505	5.471	7.183	10.263	17.085	29.304	40.722	73.015	134.112	251.367	478.895	702.501
5C15	1.211	3.805	6.212	8.388	12.426	21.724	39.025	55.597	103.551	196.226	377.127	732.580	1084.468
6B 1	0.400	1.100	1.674	2.163	3.022	4.872	8.085	11.025	19.177	34.290	62.654	117.540	170.910
6B 2	0.598	1.091	1.658	2.138	2.980	4.788	7.917	10.773	18.673	33.282	60.018	113.508	164.862
6B 3	0.272	0.765	1.180	1.538	2.175	3.568	6.030	8.310	14.704	26.699	49.568	93.718	136.978
6B10	0.503	0.830	1.261	1.626	2.266	3.639	6.015	8.182	14.176	25.257	46.156	86.082	125.009
6B11	0.409	1.071	1.583	2.002	2.715	4.179	6.588	8.706	14.348	24.561	42.591	76.514	109.009
6B13	0.272	0.765	1.180	1.538	2.175	3.568	6.030	8.310	14.704	26.699	49.568	93.718	136.978
6B16	0.584	1.066	1.632	2.116	2.972	4.827	8.074	11.062	19.587	34.903	64.555	120.926	176.246
6C 1	1.067	2.958	4.478	5.787	8.091	13.054	21.685	29.587	51.511	92.186	169.047	316.420	460.228
6C 5	0.984	2.728	4.173	5.406	7.584	12.299	20.559	28.111	49.192	88.442	162.024	305.764	445.453
6C 7	1.614	4.494	6.890	8.940	12.570	20.448	34.260	46.980	82.467	148.680	274.574	516.241	752.759
6C 8	1.508	3.894	6.190	8.223	11.929	20.283	35.509	49.905	91.052	169.721	321.929	619.090	912.177
6C11	1.669	4.705	7.264	9.471	13.402	22.007	37.232	51.340	90.952	165.248	306.999	580.769	849.071
6C16	1.151	3.441	5.483	7.296	10.605	18.082	31.741	44.671	81.079	152.522	289.719	557.764	822.244
6C17	1.229	3.481	5.388	7.037	9.979	16.440	27.905	38.547	68.474	124.758	232.277	440.172	644.057

CUMULATIVE INFILTRATION,

COTTER CATCHMENT, PIERCE'S CREEK AREA
#####8 TEMPERATE FOREST ####
AUSTRALIA,

DATE : 05/04/78
TIME : 17/24/12

BLOCK - I

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	300.	720.	1440.	2880.	4320.
	TIME(MINS)												
7A 1	1.559	5.026	8.303	11.292	16.878	29.846	54.102	77.569	145.559	277.573	535.990	1044.890	1549.553
7A 2	1.745	5.280	8.462	11.298	16.500	28.308	49.980	70.560	129.627	243.000	465.014	893.521	1318.679
7A 5	1.857	5.605	8.972	11.971	17.466	29.927	52.770	74.460	136.061	255.985	487.450	940.225	1387.295
7A 6	1.854	5.585	8.932	11.910	17.364	29.723	52.508	73.848	135.457	253.557	482.554	930.433	1372.607
7A 8	2.071	6.369	10.289	13.807	20.292	35.110	62.478	88.573	163.757	308.510	590.202	1142.476	1688.511
7A10	1.828	5.427	8.616	11.437	16.575	28.145	49.212	69.114	125.969	234.601	444.682	854.689	1258.991
7A12	1.777	5.127	8.015	10.535	15.072	25.139	43.200	60.096	107.955	198.529	372.538	710.401	1042.559
7C 2	0.502	1.456	2.282	3.004	4.308	7.208	12.420	17.316	31.184	57.492	108.087	206.423	303.154
7C 5	0.894	2.422	3.654	4.691	6.498	10.337	16.914	22.872	39.251	69.252	125.479	232.537	336.564
7C10	0.550	1.449	2.198	2.831	3.942	6.320	10.428	14.172	24.514	43.609	79.555	148.274	215.210
7C11	0.840	2.442	3.835	5.055	7.260	12.174	21.030	29.340	52.954	97.740	185.987	351.720	516.779
7C13	1.133	3.554	5.269	6.973	10.068	17.008	29.595	41.449	75.255	139.654	265.943	506.212	744.916
7C16	0.975	2.793	4.349	5.702	8.131	13.497	23.085	32.027	57.282	104.986	196.427	373.700	547.821
7C18	0.725	2.271	3.702	4.995	7.392	12.907	23.100	32.977	61.556	116.209	225.223	433.442	641.522
A1 4	1.727	4.822	7.406	9.622	13.551	22.097	37.110	50.970	89.081	162.025	299.550	564.585	823.555
A1 5	1.597	4.056	6.364	8.384	12.030	20.150	34.770	48.481	87.585	161.221	305.286	579.482	851.221
A1 6	1.504	4.267	6.611	8.638	12.260	20.218	34.554	47.488	84.440	153.980	286.088	543.976	796.161
A1 8	1.652	4.718	7.338	9.612	13.689	22.686	38.756	53.694	95.895	175.556	328.086	623.665	913.895
A110	1.777	4.891	7.450	9.624	13.449	21.683	35.989	49.081	85.585	152.702	279.051	523.564	761.552
A111	1.408	4.053	6.281	8.237	11.747	19.505	33.509	46.306	82.842	151.868	284.196	540.760	792.777
A116	1.754	4.859	7.380	9.543	13.352	21.566	35.866	48.971	85.556	152.914	280.657	525.716	764.919
A2 7	1.096	3.498	5.750	7.798	11.614	20.443	36.949	52.807	98.795	187.947	362.255	705.222	1045.015
A2 8	1.501	3.999	6.459	8.666	12.735	22.029	39.192	55.554	102.679	193.440	370.025	716.207	1058.469
A210	1.105	3.546	5.847	7.944	11.857	20.929	37.921	54.265	101.711	193.779	375.919	728.550	1080.007
A211	1.429	4.249	6.750	8.963	12.996	22.082	38.654	54.277	98.975	184.405	349.654	672.218	990.525
A212	1.216	3.854	6.269	8.475	12.570	22.012	39.601	56.461	105.259	199.682	384.059	746.404	1105.204
A213	1.054	3.564	5.531	7.502	11.175	19.675	35.568	50.838	95.124	180.984	348.065	679.200	1006.486
A218	1.509	4.555	7.291	9.728	14.193	24.319	42.888	60.510	111.059	208.052	396.142	764.112	1127.446
B1 2	2.500	6.618	10.333	13.571	19.393	32.296	55.415	77.019	138.140	253.795	475.791	906.614	1330.057
B1 6	1.972	5.897	9.396	12.499	18.167	30.969	54.552	76.486	139.852	261.080	495.080	954.593	1407.191
B1 9	2.260	6.635	10.472	13.849	19.974	33.692	58.556	81.925	148.525	275.577	520.106	996.867	1466.497
B111	2.245	6.544	10.291	13.577	19.521	32.786	56.724	79.207	143.089	264.505	498.362	953.379	1401.265
B115	2.527	7.371	11.594	15.299	22.002	36.966	63.978	89.352	161.465	298.548	562.017	1076.473	1582.506
B116	2.158	6.252	9.845	13.002	18.717	31.491	54.576	76.279	137.999	255.409	481.702	922.220	1355.976
B118	2.254	6.481	10.165	13.588	19.206	32.156	55.404	77.317	139.509	256.945	483.242	923.159	1355.905

COTTER CATCHMENT, PIERCE'S CREEK AREA
####8 TEMPERATE FOREST ####
AUSTRALIA.

DATE : 05/04/78
TIME : 17/24/25

CUMULATIVE INFILTRATION.

BLOCK - I

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
	TIME(MINS)												
B2 4	1.794	5.329	8.462	11.234	16.283	27.655	48.364	67.930	123.831	230.649	437.258	840.450	1238.064
B2 6	1.947	5.626	8.804	11.579	16.578	27.682	47.022	66.289	119.169	219.574	411.950	785.932	1153.695
B2 7	2.290	6.531	10.150	13.288	18.911	31.309	53.403	73.985	132.014	241.463	451.012	856.893	1255.549
B210	2.216	6.373	9.949	13.064	18.666	31.076	53.304	74.077	132.829	243.985	457.322	871.299	1278.145
B212	2.195	6.246	9.695	12.683	18.030	29.804	50.700	70.261	125.197	228.721	426.794	810.243	1186.561
B216	2.174	6.121	9.444	12.307	17.403	28.550	48.252	66.499	117.673	213.673	396.098	750.051	1096.273
B218	1.976	5.801	9.153	12.102	17.451	29.428	51.114	71.527	129.045	240.526	453.854	869.740	1279.407
C1 2	1.669	4.819	7.540	9.916	14.196	23.700	40.764	56.736	101.979	187.704	352.422	672.557	986.903
C1 3	1.890	5.414	8.432	11.056	15.766	26.175	44.774	62.126	111.150	203.704	381.165	725.216	1063.161
C1 5	1.508	4.597	7.396	9.900	14.503	24.986	44.288	62.654	115.462	217.000	414.308	800.768	1182.646
C1 6	1.719	4.873	7.545	9.856	13.983	23.047	39.138	54.085	96.121	175.201	326.305	618.531	905.150
C1 8	1.904	5.565	8.282	10.796	15.273	25.072	42.402	58.459	103.509	188.054	349.290	660.652	965.775
C1 9	1.843	5.284	8.234	10.801	15.411	25.607	43.857	60.853	108.929	199.790	374.027	711.916	1043.860
C110	1.492	4.624	7.500	10.088	14.871	25.832	46.134	65.527	121.475	229.405	439.054	852.218	1260.325
C2 1	1.557	4.250	6.925	9.342	13.822	24.126	43.275	61.605	114.590	216.990	416.741	809.100	1197.449
C2 2	1.536	4.207	6.876	9.291	13.776	24.111	43.556	61.800	115.171	218.424	419.991	816.145	1208.573
C2 3	1.277	4.198	6.997	9.565	14.388	25.648	46.873	67.369	127.075	243.514	471.303	920.932	1366.996
C2 9	1.563	4.534	7.115	9.640	14.342	25.213	45.515	65.009	121.513	230.998	444.987	865.917	1282.889
C211	1.510	4.114	6.714	9.064	13.425	23.463	42.137	60.024	111.755	211.775	406.962	790.465	1170.104
C214	1.552	4.159	6.721	9.019	13.256	22.938	40.822	57.875	106.995	201.609	385.710	746.658	1103.553

COTTER CATCHMENT, PIERCE'S CREEK AREA
####8 TEMPERATE FOREST ####
AUSTRALIA.

DATE : 05/04/78
TIME : 17/24/53

INFILTRATION RATE.

BLOCK - I

PLOT NO	TIME(MINS) 1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
1A5	1.018	0.441	0.324	0.273	0.221	0.169	0.132	0.116	0.094	0.079	0.069	0.061	0.058
1A7	0.955	0.451	0.329	0.283	0.238	0.192	0.160	0.146	0.127	0.114	0.105	0.098	0.095
1A8	0.786	0.553	0.266	0.227	0.188	0.149	0.122	0.109	0.095	0.082	0.074	0.068	0.066
1A10	1.180	0.551	0.400	0.342	0.284	0.225	0.184	0.165	0.141	0.124	0.113	0.104	0.100
1A11	0.857	0.386	0.295	0.255	0.214	0.173	0.145	0.132	0.115	0.105	0.095	0.089	0.087
1A12	0.926	0.422	0.320	0.274	0.229	0.183	0.151	0.137	0.118	0.105	0.096	0.089	0.086
1A16	0.903	0.398	0.296	0.251	0.206	0.160	0.128	0.114	0.095	0.082	0.072	0.066	0.063
1B 1	0.201	0.083	0.059	0.048	0.038	0.027	0.020	0.016	0.012	0.009	0.007	0.005	0.004
1B 5	0.221	0.092	0.066	0.054	0.042	0.031	0.023	0.019	0.014	0.011	0.008	0.007	0.006
1B 9	0.053	0.022	0.016	0.013	0.011	0.008	0.006	0.005	0.004	0.003	0.002	0.002	0.002
1B10	0.141	0.059	0.042	0.035	0.027	0.020	0.015	0.012	0.009	0.007	0.006	0.004	0.004
1B11	0.190	0.079	0.057	0.047	0.037	0.027	0.020	0.016	0.012	0.009	0.007	0.006	0.005
1B16	0.192	0.081	0.059	0.049	0.039	0.029	0.022	0.019	0.015	0.012	0.010	0.008	0.008
1B18	0.127	0.055	0.040	0.034	0.027	0.021	0.016	0.014	0.012	0.010	0.008	0.007	0.007
1C 3	1.194	0.545	0.413	0.355	0.297	0.238	0.197	0.179	0.155	0.138	0.126	0.117	0.113
1C 6	1.000	0.459	0.350	0.302	0.253	0.204	0.170	0.154	0.134	0.120	0.110	0.105	0.100
1C 8	1.171	0.522	0.391	0.333	0.275	0.216	0.175	0.156	0.132	0.115	0.103	0.095	0.091
1C13	1.192	0.532	0.399	0.340	0.281	0.221	0.179	0.161	0.136	0.119	0.107	0.098	0.095
1C15	1.124	0.526	0.405	0.351	0.297	0.243	0.205	0.188	0.166	0.150	0.139	0.132	0.128
1C16	1.179	0.530	0.390	0.340	0.282	0.223	0.182	0.164	0.140	0.123	0.111	0.102	0.099
1C17	1.051	0.498	0.390	0.342	0.294	0.246	0.212	0.197	0.177	0.163	0.153	0.146	0.143
2A 6	0.550	0.273	0.222	0.199	0.176	0.152	0.136	0.129	0.119	0.112	0.108	0.104	0.103
2A 7	0.725	0.395	0.329	0.299	0.270	0.240	0.219	0.209	0.197	0.189	0.185	0.178	0.176
2A 9	0.755	0.351	0.269	0.233	0.197	0.160	0.135	0.123	0.108	0.098	0.090	0.085	0.083
2A10	0.743	0.383	0.310	0.278	0.245	0.213	0.190	0.179	0.166	0.157	0.150	0.145	0.143
2A11	0.555	0.296	0.243	0.220	0.197	0.173	0.156	0.149	0.140	0.133	0.128	0.125	0.123
2A15	0.587	0.299	0.241	0.215	0.189	0.163	0.144	0.136	0.125	0.118	0.113	0.109	0.107
2A16	0.591	0.302	0.244	0.218	0.192	0.166	0.148	0.140	0.129	0.121	0.116	0.112	0.111
2C 2	1.191	0.592	0.471	0.418	0.364	0.310	0.272	0.255	0.233	0.217	0.206	0.198	0.195
2C 4	0.965	0.459	0.357	0.311	0.266	0.220	0.188	0.174	0.155	0.142	0.133	0.126	0.123
2C 6	0.869	0.456	0.349	0.310	0.271	0.232	0.204	0.192	0.176	0.165	0.157	0.151	0.149
2C 9	1.070	0.551	0.446	0.400	0.353	0.306	0.275	0.258	0.239	0.225	0.216	0.209	0.206
2C12	0.948	0.443	0.341	0.296	0.250	0.205	0.172	0.158	0.140	0.126	0.117	0.110	0.108
2C16	0.808	0.397	0.314	0.277	0.240	0.203	0.176	0.165	0.150	0.139	0.131	0.126	0.124
2C18	0.940	0.471	0.377	0.335	0.293	0.250	0.220	0.207	0.190	0.178	0.169	0.163	0.160

INFILTRATION RATE. COTTER CATCHMENT, PIERCE'S CREEK AREA
TEMPERATE FOREST
AUSTRALIA.

DATE : 05/04/78
TIME : 17/24/43

BLOCK - I

TIME(MINS)

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
3A 2	0.723	0.339	0.261	0.227	0.192	0.157	0.135	0.122	0.108	0.098	0.091	0.086	0.083
3A 3	0.599	0.270	0.203	0.174	0.144	0.114	0.095	0.084	0.072	0.063	0.057	0.055	0.051
3A 4	0.822	0.426	0.346	0.310	0.274	0.239	0.213	0.202	0.187	0.177	0.170	0.165	0.162
3A 6	0.552	0.263	0.205	0.179	0.153	0.127	0.109	0.101	0.090	0.083	0.077	0.073	0.072
3A11	0.865	0.432	0.344	0.306	0.267	0.228	0.200	0.188	0.172	0.161	0.153	0.147	0.145
3A14	0.577	0.260	0.196	0.167	0.139	0.110	0.090	0.081	0.069	0.061	0.055	0.051	0.049
3A16	0.619	0.331	0.272	0.247	0.221	0.195	0.176	0.168	0.157	0.150	0.145	0.141	0.139
3B 1	0.193	0.117	0.102	0.095	0.088	0.081	0.076	0.074	0.071	0.069	0.068	0.067	0.067
3B 6	0.242	0.131	0.108	0.098	0.088	0.078	0.071	0.068	0.064	0.061	0.059	0.057	0.057
3B 8	0.250	0.114	0.091	0.081	0.070	0.060	0.053	0.049	0.045	0.042	0.040	0.038	0.038
3B 9	0.293	0.143	0.112	0.099	0.085	0.071	0.062	0.058	0.052	0.048	0.045	0.043	0.042
3B10	0.233	0.122	0.090	0.089	0.079	0.069	0.062	0.059	0.055	0.052	0.050	0.048	0.048
3B11	0.162	0.089	0.075	0.068	0.062	0.055	0.051	0.049	0.046	0.044	0.043	0.042	0.042
3B17	0.160	0.088	0.073	0.067	0.060	0.054	0.049	0.047	0.044	0.042	0.041	0.040	0.040
3C 2	0.644	0.327	0.263	0.234	0.206	0.177	0.157	0.148	0.136	0.128	0.122	0.118	0.116
3C 5	0.531	0.271	0.219	0.196	0.172	0.149	0.132	0.125	0.115	0.108	0.104	0.100	0.099
3C 6	0.591	0.326	0.273	0.249	0.225	0.201	0.185	0.177	0.167	0.160	0.155	0.152	0.151
3C 9	0.608	0.319	0.261	0.235	0.209	0.183	0.165	0.157	0.146	0.139	0.133	0.129	0.128
3C15	0.853	0.389	0.299	0.260	0.220	0.180	0.151	0.139	0.122	0.111	0.103	0.097	0.094
3C17	0.891	0.458	0.371	0.332	0.293	0.254	0.227	0.214	0.198	0.187	0.179	0.174	0.171
3C18	0.709	0.384	0.318	0.289	0.260	0.231	0.210	0.201	0.189	0.181	0.175	0.170	0.168
4A 3	1.274	0.676	0.555	0.501	0.447	0.393	0.355	0.338	0.316	0.300	0.289	0.282	0.278
4A 4	0.985	0.487	0.386	0.342	0.297	0.252	0.220	0.206	0.188	0.175	0.166	0.159	0.156
4A 9	1.007	0.502	0.400	0.355	0.310	0.264	0.232	0.218	0.199	0.186	0.176	0.170	0.167
4A12	1.001	0.497	0.395	0.349	0.304	0.259	0.226	0.212	0.193	0.180	0.171	0.164	0.161
4A14	1.318	0.713	0.590	0.536	0.482	0.427	0.388	0.371	0.349	0.333	0.322	0.314	0.310
4A15	1.309	0.732	0.615	0.564	0.512	0.460	0.423	0.406	0.385	0.370	0.359	0.352	0.349
4A16	1.267	0.618	0.487	0.429	0.371	0.312	0.271	0.252	0.228	0.211	0.199	0.191	0.187
4C 1	1.295	0.768	0.662	0.615	0.568	0.520	0.486	0.471	0.452	0.438	0.429	0.422	0.419
4C 2	1.254	0.714	0.605	0.556	0.508	0.459	0.424	0.409	0.389	0.375	0.365	0.358	0.355
4C 3	1.154	0.649	0.547	0.502	0.456	0.411	0.378	0.364	0.346	0.332	0.323	0.316	0.314
4C 5	1.305	0.687	0.562	0.507	0.451	0.395	0.356	0.338	0.316	0.299	0.288	0.280	0.276
4C 8	0.920	0.473	0.383	0.342	0.302	0.262	0.233	0.221	0.204	0.193	0.184	0.178	0.176
4C15	1.177	0.600	0.484	0.432	0.380	0.328	0.291	0.275	0.253	0.238	0.228	0.220	0.217
4C18	1.048	0.579	0.484	0.442	0.400	0.358	0.328	0.314	0.297	0.285	0.276	0.270	0.267

INFILTRATION RATE.

COTTER CATCHMENT, PIERCE'S CREEK AREA
#####8 TEMPERATE FOREST ####
AUSTRALIA.

DATE : 05/04/78
TIME : 17/24/50

BLOCK - I

PLOT NO	TIME(MINS) 1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
5A 3	1.011	0.506	0.404	0.359	0.314	0.268	0.250	0.221	0.205	0.190	0.180	0.174	0.171
5A 4	1.040	0.513	0.407	0.360	0.313	0.265	0.232	0.217	0.197	0.183	0.174	0.167	0.164
5A 7	1.069	0.564	0.462	0.417	0.371	0.326	0.293	0.279	0.261	0.247	0.238	0.231	0.229
5A 8	0.928	0.485	0.396	0.356	0.317	0.277	0.249	0.236	0.220	0.208	0.200	0.194	0.192
5A10	0.850	0.454	0.373	0.338	0.302	0.266	0.241	0.230	0.215	0.205	0.198	0.192	0.190
5A17	0.855	0.445	0.366	0.332	0.297	0.261	0.237	0.226	0.211	0.201	0.194	0.189	0.187
5A18	1.155	0.578	0.461	0.410	0.358	0.306	0.269	0.252	0.231	0.216	0.205	0.198	0.195
5B 1	0.065	0.027	0.020	0.017	0.013	0.010	0.008	0.007	0.005	0.004	0.004	0.003	0.003
5B 2	0.068	0.029	0.021	0.018	0.014	0.010	0.008	0.007	0.005	0.004	0.004	0.003	0.003
5B 3	0.066	0.028	0.020	0.017	0.014	0.010	0.008	0.007	0.005	0.004	0.004	0.003	0.003
5B 5	0.072	0.030	0.022	0.018	0.014	0.010	0.008	0.007	0.005	0.004	0.005	0.003	0.002
5B 8	0.083	0.035	0.025	0.021	0.017	0.012	0.009	0.008	0.006	0.005	0.004	0.003	0.003
5B15	0.065	0.027	0.020	0.016	0.013	0.010	0.007	0.006	0.005	0.004	0.003	0.002	0.002
5B17	0.075	0.032	0.023	0.019	0.015	0.012	0.009	0.008	0.006	0.005	0.004	0.003	0.003
5C 1	0.457	0.225	0.182	0.163	0.143	0.124	0.111	0.105	0.097	0.091	0.087	0.085	0.083
5C 3	0.464	0.248	0.204	0.185	0.165	0.146	0.132	0.126	0.118	0.112	0.108	0.106	0.104
5C 5	0.878	0.475	0.393	0.357	0.321	0.284	0.258	0.247	0.232	0.221	0.214	0.209	0.206
5C 6	0.696	0.451	0.378	0.354	0.330	0.307	0.290	0.282	0.272	0.266	0.261	0.257	0.256
5C11	0.655	0.424	0.378	0.357	0.336	0.316	0.301	0.294	0.286	0.280	0.276	0.275	0.271
5C14	0.683	0.365	0.301	0.273	0.244	0.216	0.195	0.186	0.175	0.166	0.160	0.156	0.154
5C15	0.724	0.455	0.377	0.351	0.325	0.299	0.281	0.273	0.262	0.254	0.249	0.245	0.244
6B 1	0.217	0.109	0.087	0.077	0.067	0.058	0.051	0.048	0.044	0.041	0.039	0.037	0.037
6B 2	0.215	0.107	0.085	0.076	0.066	0.056	0.049	0.046	0.042	0.039	0.037	0.036	0.035
6B 3	0.150	0.078	0.063	0.057	0.050	0.044	0.039	0.037	0.034	0.033	0.031	0.030	0.030
6B10	0.164	0.082	0.065	0.058	0.050	0.043	0.037	0.035	0.032	0.030	0.028	0.027	0.027
6B11	0.214	0.099	0.076	0.065	0.055	0.044	0.037	0.034	0.030	0.027	0.024	0.023	0.022
6B13	0.150	0.078	0.063	0.057	0.050	0.044	0.039	0.037	0.034	0.033	0.031	0.030	0.030
6B16	0.210	0.107	0.086	0.077	0.067	0.058	0.051	0.048	0.045	0.042	0.040	0.039	0.038
6C 1	0.579	0.291	0.232	0.207	0.181	0.155	0.136	0.128	0.117	0.110	0.105	0.101	0.099
6C 5	0.537	0.272	0.219	0.195	0.171	0.147	0.130	0.123	0.115	0.106	0.101	0.098	0.096
6C 7	0.883	0.451	0.363	0.324	0.285	0.246	0.219	0.207	0.191	0.179	0.171	0.166	0.163
6C 8	0.751	0.422	0.355	0.326	0.296	0.266	0.245	0.236	0.224	0.215	0.209	0.205	0.203
6C11	0.921	0.479	0.390	0.350	0.310	0.270	0.242	0.230	0.215	0.202	0.193	0.188	0.185
6C16	0.663	0.375	0.316	0.290	0.265	0.238	0.220	0.212	0.201	0.194	0.188	0.185	0.183
6C17	0.681	0.356	0.291	0.262	0.233	0.203	0.182	0.173	0.161	0.153	0.147	0.145	0.141

INFILTRATION RATE.

COTTER CATCHMENT, PIERCE'S CREEK AREA
####8 TEMPERATE FOREST ####
AUSTRALIA,

DATE : 05/04/78
TIME : 17/24/56

BLOCK - I

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
						TIME(MINS)							
7A 1	0.949	0.589	0.516	0.484	0.451	0.419	0.390	0.386	0.372	0.363	0.356	0.351	0.349
7A 2	1.014	0.582	0.494	0.455	0.416	0.377	0.350	0.338	0.322	0.310	0.302	0.297	0.294
7A 5	1.077	0.616	0.523	0.481	0.440	0.398	0.369	0.356	0.339	0.326	0.318	0.312	0.309
7A 6	1.074	0.612	0.519	0.478	0.436	0.395	0.365	0.352	0.335	0.323	0.315	0.309	0.306
7A 8	1.218	0.713	0.611	0.566	0.521	0.475	0.445	0.428	0.410	0.397	0.387	0.381	0.378
7A10	1.048	0.586	0.493	0.452	0.410	0.368	0.339	0.326	0.309	0.297	0.288	0.282	0.280
7A12	0.998	0.556	0.443	0.401	0.360	0.318	0.289	0.276	0.259	0.247	0.238	0.232	0.229
7C 2	0.283	0.153	0.127	0.115	0.104	0.092	0.084	0.080	0.075	0.072	0.069	0.068	0.067
7C 5	0.480	0.254	0.185	0.163	0.141	0.119	0.103	0.096	0.087	0.081	0.076	0.075	0.072
7C10	0.286	0.142	0.113	0.100	0.087	0.074	0.065	0.061	0.055	0.051	0.049	0.047	0.046
7C11	0.474	0.258	0.214	0.195	0.175	0.156	0.142	0.136	0.128	0.122	0.118	0.115	0.114
7C13	0.645	0.357	0.298	0.273	0.247	0.221	0.202	0.194	0.183	0.176	0.170	0.167	0.165
7C16	0.545	0.290	0.238	0.215	0.192	0.169	0.155	0.146	0.136	0.130	0.125	0.122	0.120
7C18	0.432	0.259	0.224	0.209	0.193	0.177	0.166	0.161	0.155	0.151	0.147	0.145	0.144
A1 4	0.947	0.485	0.392	0.351	0.309	0.268	0.238	0.225	0.208	0.196	0.187	0.181	0.179
A1 5	0.788	0.427	0.354	0.322	0.290	0.257	0.234	0.224	0.211	0.201	0.195	0.190	0.188
A1 6	0.854	0.458	0.357	0.322	0.286	0.250	0.225	0.214	0.199	0.189	0.182	0.176	0.174
A1 8	0.921	0.488	0.400	0.362	0.323	0.284	0.256	0.244	0.228	0.217	0.209	0.203	0.200
A110	0.964	0.483	0.386	0.343	0.300	0.256	0.220	0.212	0.194	0.182	0.173	0.167	0.164
A111	0.786	0.418	0.344	0.311	0.278	0.245	0.221	0.211	0.197	0.188	0.181	0.176	0.174
A116	0.953	0.480	0.384	0.341	0.299	0.256	0.226	0.212	0.195	0.183	0.174	0.168	0.165
A2 7	0.663	0.406	0.354	0.331	0.308	0.285	0.268	0.261	0.252	0.245	0.240	0.237	0.235
A2 8	0.765	0.448	0.383	0.355	0.327	0.298	0.278	0.269	0.257	0.249	0.243	0.239	0.237
A210	0.671	0.414	0.362	0.339	0.316	0.293	0.276	0.269	0.260	0.253	0.248	0.245	0.243
A211	0.820	0.459	0.387	0.354	0.322	0.289	0.266	0.256	0.245	0.233	0.227	0.222	0.220
A212	0.728	0.440	0.382	0.356	0.330	0.304	0.286	0.277	0.267	0.259	0.254	0.250	0.248
A213	0.657	0.390	0.341	0.319	0.296	0.274	0.258	0.251	0.242	0.236	0.231	0.228	0.227
A218	0.875	0.500	0.425	0.391	0.357	0.324	0.300	0.289	0.275	0.265	0.258	0.254	0.251
B1 2	1.289	0.690	0.569	0.516	0.462	0.408	0.369	0.352	0.330	0.315	0.304	0.296	0.292
B1 6	1.136	0.642	0.542	0.497	0.453	0.408	0.377	0.363	0.344	0.331	0.322	0.316	0.313
B1 9	1.285	0.708	0.591	0.540	0.488	0.436	0.399	0.382	0.361	0.346	0.335	0.328	0.325
B111	1.270	0.693	0.576	0.524	0.473	0.421	0.384	0.367	0.346	0.331	0.320	0.313	0.310
B115	1.430	0.781	0.650	0.591	0.533	0.474	0.435	0.415	0.391	0.374	0.362	0.355	0.350
B116	1.212	0.664	0.553	0.504	0.455	0.405	0.370	0.355	0.335	0.320	0.310	0.305	0.300
B118	1.259	0.682	0.566	0.514	0.462	0.410	0.375	0.357	0.336	0.321	0.310	0.302	0.299

INFILTRATION RATE.

COTTER CATCHMENT, PIERCE'S CREEK AREA
####8 TEMPERATE FOREST ####
AUSTRALIA,

DATE : 05/04/78
TIME : 17/25/02

BLOCK - I

PLOT NO	10.	60.	120.	180.	300.	600.	1200.	1800.	3000.	7200.	14400.	28800.	43200.
	TIME(MINS)												
B2 4	1.029	0.576	0.484	0.444	0.403	0.362	0.333	0.320	0.304	0.292	0.285	0.278	0.275
B2 6	1.094	0.589	0.487	0.442	0.397	0.351	0.319	0.305	0.286	0.273	0.264	0.257	0.254
B2 7	1.275	0.674	0.553	0.499	0.445	0.391	0.352	0.335	0.313	0.298	0.286	0.279	0.275
B210	1.241	0.664	0.548	0.496	0.444	0.392	0.355	0.339	0.318	0.303	0.292	0.284	0.281
B212	1.220	0.643	0.526	0.475	0.423	0.371	0.334	0.318	0.296	0.281	0.271	0.263	0.260
B216	1.199	0.622	0.506	0.454	0.402	0.350	0.313	0.297	0.275	0.260	0.250	0.242	0.259
B218	1.123	0.618	0.516	0.471	0.426	0.380	0.348	0.334	0.315	0.302	0.295	0.286	0.283
C1 2	0.937	0.505	0.417	0.379	0.340	0.301	0.273	0.261	0.245	0.253	0.225	0.220	0.217
C1 3	1.056	0.562	0.462	0.417	0.373	0.328	0.297	0.283	0.265	0.252	0.243	0.236	0.253
C1 5	0.881	0.510	0.436	0.402	0.369	0.336	0.312	0.301	0.288	0.278	0.271	0.266	0.264
C1 6	0.953	0.499	0.407	0.367	0.326	0.285	0.256	0.243	0.227	0.215	0.206	0.200	0.198
C1 8	1.051	0.546	0.444	0.399	0.353	0.308	0.275	0.261	0.243	0.229	0.220	0.213	0.211
C1 9	1.050	0.549	0.452	0.408	0.365	0.322	0.291	0.277	0.260	0.247	0.258	0.232	0.229
C110	0.883	0.522	0.449	0.417	0.384	0.352	0.329	0.319	0.305	0.296	0.289	0.285	0.282
C2 1	0.809	0.484	0.419	0.390	0.361	0.331	0.311	0.301	0.289	0.281	0.275	0.271	0.269
C2 2	0.800	0.482	0.418	0.390	0.361	0.333	0.312	0.303	0.292	0.283	0.278	0.273	0.272
C2 3	0.789	0.501	0.442	0.417	0.391	0.365	0.346	0.338	0.327	0.320	0.314	0.311	0.309
C2 9	0.822	0.501	0.437	0.408	0.379	0.350	0.330	0.321	0.309	0.301	0.295	0.291	0.289
C211	0.783	0.470	0.407	0.379	0.351	0.323	0.303	0.294	0.285	0.274	0.269	0.265	0.263
C214	0.795	0.466	0.399	0.370	0.340	0.310	0.289	0.280	0.268	0.259	0.255	0.249	0.247

APPENDIX 5.6
Sheet 1 of 2

LOWER COTTER CATCHMENT

URIARRA FOREST COMPARTMENT 62

Results of field measurements of soil moisture content, sorptivity, hydraulic conductivity and infiltration

Site & sample No.		Gravimetric moisture content (%)	Sorptivity cm $min.^{-\frac{1}{2}}$ (S)	Hydraulic conductivity cm $min.^{-1}$ (K)	Infiltration (1 min.) Cumulative (cm)	Rate cm min^{-1}
A_1	4	20.0	1.56	0.467	1.73	0.947
	5	23.4	1.22	0.500	1.40	0.788
	6	20.8	1.34	0.459	1.50	0.834
	8	20.7	1.46	0.530	1.65	0.921
	10	17.3	1.63	0.424	1.78	0.964
	11	21.7	1.24	0.461	1.41	0.786
	16	19.0	1.60	0.428	1.75	0.953
A_2	7	22.0	0.868	0.640	1.10	0.663
	8	20.6	1.07	0.640	1.30	0.765
	10	21.8	0.868	0.663	1.10	0.671
	11	19.5	1.22	0.590	1.43	0.820
	12	20.4	0.975	0.675	1.22	0.728
	13	23.4	0.834	0.617	1.05	0.637
	18	19.6	1.27	0.677	1.51	0.875
B_1	2	17.7	2.02	0.776	2.30	1.29
	6	21.1	1.67	0.841	1.97	1.14
	9	18.0	1.95	0.868	2.26	1.29
	11	20.0	1.95	0.825	2.24	1.27
	15	16.3	2.19	0.932	2.53	1.43
	16	20.2	1.85	0.800	2.14	1.21
	18	19.3	1.95	0.796	2.23	1.26
B_2	4	22.0	1.53	0.737	1.79	1.03
	6	21.7	1.71	0.675	1.95	1.09
	7	19.5	2.03	0.727	2.29	1.28
	10	20.2	1.95	0.746	2.22	1.24
	12	19.8	1.95	0.686	2.19	1.22
	16	19.7	1.95	0.628	2.17	1.20
	18	20.9	1.70	0.757	1.98	1.12

APPENDIX 5.6
Sheet 2 of 2

Site & sample No.		Gravimetric moisture content (%)	Sorptivity cm min.$^{-\frac{1}{2}}$ (S)	Hydraulic conductivity cm min.$^{-1}$ (K)	Infiltration (1 min.) Cumulative (cm)	Infiltration (1 min.) Rate cm min^{-1}
C_1	2	21.2	1.46	0.578	1.67	0.937
	3	20.7	1.67	0.618	1.89	1.06
	5	21.6	1.25	0.713	1.51	0.881
	6	20.6	1.53	0.521	1.72	0.953
	8	20.2	1.71	0.553	1.90	1.05
	9	20.5	1.63	0.607	1.84	1.03
	10	21.6	1.22	0.765	1.49	0.883
C_2	1	18.5	1.10	0.729	1.36	0.809
	2	19.6	1.07	0.737	1.34	0.800
	3	19.5	0.975	0.844	1.28	0.789
	9	19.0	1.08	0.786	1.36	0.822
	11	20.1	1.06	0.713	1.31	0.783
	14	18.8	1.11	0.668	1.35	0.795
	15	17.4	1.36	0.671	1.60	0.870

Test of Significance on Variation of slopes

Blocks on: Higer & Steeper slope	Blocks on: Lower & gentle slope	df	t	Remarks
Sorptivity , Eucalypt Forests				
1A, 2A, 7A	1C, 7C	33	0.3126	Not sig.at .5 Level
Sorptivity , Pine Plantations				
4A, 5A,	2C,3C,4C,5C,6C	47	3.7191	Significant
Infiltration , Eucalypt Forest				
1A, 2A, 7A	1C, 7C	33	0.6276	Not sig. at .5 Level
Infiltration , Pine Plantations				
4 A, 5A	2C,3C,4C,5C,6C	47	3.5749	Significant

APPENDIX 5.8
Sheet 1 of 5

KYETMAUK-TAUNG CATCHMENT
(Mt Poppa)

Results of field measurements for soil moisture content, sorptivity, hydraulic conductivity and infiltration
(Dry Season)

Site & sample No.		Gravimetric moisture content (%)	Sorptivity cm min.$^{-\frac{1}{2}}$ (S)	Hydraulic conductivity cm min.$^{-1}$ (K)	Infiltration (1 min.) Cumulative (cm)	Rate cm min.$^{-1}$
			BLOCK 1			
A	1	11.1	1.79	0.592	2.00	1.11
	9	11.0	1.71	0.537	1.90	1.05
	10	12.1	1.58	0.617	1.80	1.01
	18	11.3	1.74	0.590	1.95	1.08
	26	12.0	1.52	0.684	1.77	1.01
	34	10.5	1.91	0.606	2.13	1.17
	41	11.2	1.74	0.675	1.98	1.11
	42	10.3	1.91	0.584	2.12	1.17
	49	10.1	1.93	0.527	2.11	1.15
	50	10.7	1.86	0.465	2.03	1.10
	58	12.7	1.40	0.506	1.58	0.881
B	65	6.98	1.90	0.502	2.08	1.130
	73	9.56	1.34	0.485	1.51	0.843
	74	8.98	1.49	0.402	1.63	0.887
	81	8.24	1.55	0.536	1.74	0.065
	89	7.71	1.66	0.436	1.81	0.984
	90	7.57	1.65	0.402	1.79	0.966
	97	7.13	1.61	0.503	1.79	0.984
	106	7.37	1.78	0.384	1.92	1.027
C	113	6.89	1.40	0.434	1.56	0.856
	121	6.78	1.46	0.368	1.60	0.863
	122	6.97	1.41	0.386	1.55	0.845
	130	7.68	1.27	0.318	1.38	0.747
	137	8.02	1.15	0.373	1.28	0.706
	138	7.69	1.22	0.381	1.35	0.745
	145	8.02	1.12	0.319	1.23	0.674

APPENDIX 5.8
Sheet 2 of 5

Site & sample No.		Gravimetric moisture content (%)	Sorptivity cm. min.$^{-½}$ (S)	Hydraulic conductivity cm min.$^{-1}$ (K)	Infiltration (1 min.) Cumulative (cm)	Rate cm min.$^{-1}$
C	153	6.02	1.51	0.320	1.63	0.870
	154	8.24	1.13	0.295	1.24	0.672
	162	9.02	0.926	0.260	1.02	0.556
	170	7.82	1.22	0.296	1.32	0.715
	177	7.03	1.36	0.225	1.45	0.763
	185	8.70	1.02	0.284	1.12	0.613
				BLOCK II		
A	4	11.9	1.58	0.829	1.88	1.09
	11	11.9	1.65	0.613	1.86	1.04
	12	12.6	1.50	0.675	1.74	0.990
	19	10.8	1.86	0.579	2.07	1.14
	20	11.1	1.74	0.617	1.96	1.09
	27	12.5	1.50	0.547	1.69	0.945
	28	11.2	1.74	0.595	1.96	1.08
	43	10.1	2.00	0.559	2.20	1.20
	51	10.4	1.82	0.565	2.02	1.11
	52	10.4	1.85	0.558	2.05	1.13
	59	12.1	1.52	0.681	1.27	1.01
	60	10.2	1.90	0.520	2.09	1.14
	67	10.1	1.97	0.514	2.16	1.17
	68	11.2	1.71	0.496	1.88	1.03
B	75	7.23	1.69	0.684	2.04	1.09
	76	6.89	1.95	0.490	2.12	1.15
	83	8.68	1.46	0.504	1.64	0.911
	84	9.20	1.36	0.526	1.55	0.870
	99	6.86	1.80	0.460	1.97	1.07
	100	7.88	1.78	0.476	1.95	1.07
	115	7.68	1.68	0.465	1.85	1.01
	116	7.36	1.77	0.433	1.92	1.04
C	124	5.23	1.78	0.417	1.93	1.04
	132	6.70	1.41	0.355	1.54	0.834
	139	6.76	1.46	0.395	1.60	0.872

APPENDIX 5.8
Sheet 3 of 5

Site & sample No.		Gravimetric moisture content (%)	Sorptivity cm min.$^{-1/2}$ (S)	Hydraulic conductivity cm min.$^{-1}$ (K)	Infiltration (1 min.) Cumulative (cm)	Rate cm min.$^{-1}$
C	140	7.60	1.22	0.441	1.38	0.763
	147	7.66	1.22	0.294	1.32	0.714
	148	6.79	1.46	0.287	1.56	0.834
	155	7.68	1.24	0.299	1.35	0.728
	156	7.03	1.34	0.285	1.44	0.772
	163	8.67	1.02	0.305	1.13	0.621
	172	7.91	1.24	0.236	1.33	0.706
	180	7.30	1.34	0.293	1.45	0.775
	188	9.06	0.926	0.299	1.03	0.570
				BLOCK III		
A	5	11.0	1.77	0.638	2.00	1.11
	6	11.7	1.65	0.613	1.86	1.04
	13	11.6	1.67	0.637	1.90	1.06
	14	12.0	1.58	0.623	1.81	1.02
	21	11.0	1.77	0.640	2.00	1.11
	22	8.98	2.01	0.573	2.22	1.21
	29	10.6	1.91	0.648	2.15	1.19
	30	10.4	1.99	0.604	2.20	1.21
	45	8.68	2.05	0.495	2.22	1.20
	46	8.58	2.07	0.501	2.25	1.22
B	61	7.97	1.66	0.485	1.83	1.00
	62	9.24	1.36	0.530	1.55	0.872
	69	8.33	1.52	0.466	1.69	0.928
	70	7.86	1.68	0.450	1.84	1.00
	77	9.02	1.34	0.668	1.58	0.909
	78	10.2	1.07	0.655	1.33	0.769
	86	10.1	1.15	0.540	1.34	0.766
	94	7.33	1.68	0.389	1.82	0.980
	101	7.79	1.65	0.372	1.78	0.956
	102	7.89	1.66	0.563	1.86	1.03
	109	7.34	1.71	0.472	1.88	1.02
	110	7.87	1.62	0.435	1.78	0.966
	117	7.81	1.71	0.287	1.81	0.956
	118	8.68	1.46	0.427	1.61	0.884

Site & sample No.		Gravimetric moisture content (%)	Sorptivity cm min.$^{-1/2}$ (S)	Hydraulic conductivity cm min.$^{-1}$ (K)	Infiltration (1 min.) Cumulative (cm)	Infiltration (1 min.) Rate cm min.$^{-1}$
C	133	6.79	1.46	0.357	1.59	0.859
	134	7.68	1.22	0.340	1.34	0.731
	142	6.70	1.46	0.433	1.62	0.886
	150	6.82	1.49	0.297	1.59	0.849
	158	8.61	1.07	0.247	1.16	0.625
	165	8.24	1.17	0.265	1.26	0.680
	173	8.31	1.15	0.289	1.25	0.676
	174	7.88	1.34	0.276	1.44	0.769
	182	8.27	1.17	0.238	1.25	0.670
	189	7.69	1.22	0.298	1.33	0.716
				BLOCK IV		
A	8	10.9	1.83	0.555	2.83	1.11
	15	11.1	1.77	0.632	1.99	1.11
	16	12.2	1.52	0.719	1.78	1.02
	23	11.7	1.65	0.507	1.83	1.00
	24	8.82	2.13	0.760	2.37	1.30
	31	8.78	2.11	0.580	2.32	1.26
	32	8.54	2.04	0.531	2.22	1.21
	39	10.3	1.86	0.544	2.06	1.13
	40	12.1	1.55	0.686	1.79	1.02
	47	11.2	1.79	0.617	2.01	1.12
B	55	8.64	1.50	0.559	1.70	0.949
	56	8.48	1.57	0.577	1.78	0.992
	63	9.68	1.26	0.527	1.44	0.816
	64	9.43	1.34	0.627	1.56	0.894
	71	8.47	1.58	0.501	1.76	0.971
	79	7.66	1.66	0.493	1.83	1.01
	87	8.58	1.58	0.405	1.73	0.937
	88	9.32	1.34	0.524	1.53	0.857
	103	8.67	1.43	0.357	1.55	0.840
	104	8.23	1.56	0.478	1.73	0.951
	111	8.32	1.51	0.459	1.68	0.919
	112	9.39	1.38	0.526	1.56	0.876
	119	9.78	1.36	0.472	1.50	0.815
	120	8.64	1.56	0.459	1.72	0.944

APPENDIX 5.8
Sheet 5 of 5

Site & Sample No.	Gravimetric moisture content (%)	Sorptivity cm min.$^{-\frac{1}{2}}$ (S)	Hydraulic conductivity cm min^{-1} (K)	Infiltration (1 min) Cumulative (cm)	Rate cm min.$^{-1}$
C 127	5.67	1.68	0.367	1.81	0.972
135	6.13	1.53	0.359	1.66	0.896
136	5.67	1.63	0.381	1.77	0.953
144	6.11	1.56	0.445	1.72	0.939
159	8.91	1.10	0.278	1.20	0.647
160	7.70	1.22	0.298	1.33	0.716
175	7.23	1.39	0.356	1.52	0.822
184	7.06	1.34	0.209	1.42	0.745
191	8.90	1.05	0.299	1.16	0.631

CUMULATIVE INFILTRATION,

KYEINAUK-TAUNG CATCHMENT AREA, MI... PURPA
TROPICAL FOREST
BURMA.

DATE : 06/04/78
TIME : 09/53/58
PAGE : 1

BLOCK - I

TIME(MINS)

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	300.	720.	1440.	2880.	4320.
A 1	2.003	5.657	8.744	11.408	16.157	26.567	45.005	62.105	110.151	200.551	372.345	705.262	1051.429
A 9	1.898	5.329	8.210	10.688	15.093	24.712	41.082	57.379	101.549	183.754	340.050	643.572	959.855
A 10	1.805	5.203	8.132	10.687	15.287	25.490	43.791	60.910	109.568	201.127	377.552	719.480	1055.827
A 18	1.953	5.532	8.564	11.184	15.863	26.135	44.562	61.289	108.881	198.594	369.595	700.051	1024.554
A 26	1.768	5.197	8.209	10.861	15.673	26.458	46.004	64.413	116.852	216.775	409.601	785.538	1155.504
A 34	2.150	5.984	9.223	12.011	16.969	27.798	46.915	64.604	114.170	207.075	384.077	725.622	1060.171
A 41	1.984	5.714	8.928	11.730	16.772	27.953	47.998	66.743	119.789	220.210	415.027	787.515	1155.250
A 42	2.122	5.958	9.131	11.872	16.738	27.336	45.991	63.218	111.598	201.551	372.789	703.440	1026.907
A 49	2.114	5.845	8.927	11.555	16.189	26.201	43.665	59.691	104.250	187.099	343.952	645.061	939.149
A 50	2.051	5.565	8.454	10.902	15.199	24.415	40.570	54.932	95.210	169.696	310.085	578.721	840.558
A 58	1.582	4.517	7.023	9.199	13.097	21.698	37.037	51.329	91.644	167.710	315.591	595.628	872.740
B 65	2.080	5.732	8.736	11.292	15.789	25.479	42.551	57.763	100.585	180.059	330.193	618.125	899.104
B 73	1.514	4.322	6.721	8.803	12.536	20.770	35.458	49.144	87.752	160.604	300.156	570.472	835.905
B 74	1.650	4.502	6.871	8.889	12.446	20.121	33.495	45.760	79.854	143.145	262.916	492.782	717.210
B 81	1.759	4.959	7.657	10.010	14.216	23.466	39.910	55.199	98.254	179.265	334.205	634.002	928.141
B 89	1.813	4.993	7.607	9.831	13.743	22.168	36.810	50.226	87.427	156.453	286.614	536.785	780.695
B 90	1.789	4.892	7.424	9.567	13.322	21.366	35.266	47.939	82.947	147.609	269.559	502.147	728.918
B 97	1.788	5.018	7.728	10.058	14.199	23.237	39.174	53.911	95.179	172.478	319.670	603.580	881.607
B106	1.916	5.180	7.808	10.015	13.856	22.002	35.951	48.532	83.080	146.584	264.600	490.047	708.788
C113	1.556	4.362	6.713	8.732	12.320	20.144	33.929	46.667	82.520	149.062	276.095	521.030	760.852
C121	1.594	4.370	6.642	8.568	11.949	19.206	31.776	43.254	75.015	133.776	244.566	456.625	663.555
C122	1.552	4.290	6.551	8.478	11.877	19.218	32.022	43.771	76.451	137.150	252.078	472.731	688.214
C130	1.381	3.786	5.754	7.422	10.350	16.633	27.516	37.452	64.943	115.800	211.078	395.184	574.054
C137	1.279	3.605	5.566	7.256	10.268	16.860	28.521	39.328	69.652	126.572	235.156	444.807	650.289
C138	1.355	3.800	5.851	7.615	10.749	17.588	29.646	40.795	72.011	130.477	241.798	456.506	666.757
C145	1.255	3.429	5.248	6.803	9.552	15.507	25.926	35.508	62.205	111.949	206.275	387.620	564.877
C153	1.625	4.387	6.605	8.467	11.703	18.558	30.258	40.831	69.785	122.774	221.794	409.996	592.670
C154	1.259	3.407	5.189	6.702	9.364	15.091	25.040	34.142	59.577	106.156	194.498	363.801	528.959
C162	1.019	2.826	4.323	5.602	7.860	12.748	21.294	29.148	51.017	91.741	168.925	317.257	462.204
C170	1.324	3.619	5.490	7.073	9.846	15.782	26.034	35.377	61.175	108.805	198.454	369.818	536.725
C177	1.445	3.826	5.693	7.238	9.888	15.396	24.600	32.784	54.841	94.512	167.570	304.800	437.038
C185	1.125	3.115	4.761	6.165	8.643	14.002	23.558	31.950	55.855	100.553	184.575	346.594	504.468

CUMULATIVE INFILTRATION.

KYETMAUK-TAUNG CATCHMENT AREA, MT. POPPA
******** TROPICAL FOREST ********
BURMA.

BLOCK - II

TIME(MINS)

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
A 4	1.880	5.657	9.040	12.050	17.558	30.032	52.875	74.536	136.020	255.651	480.560	937.502	1382.851
A 11	1.864	5.343	8.326	10.920	15.578	25.878	44.290	61.475	110.019	201.755	377.047	718.725	1053.782
A 12	1.740	5.117	8.083	10.696	15.437	26.065	45.329	63.473	115.166	213.670	405.779	774.237	1159.212
A 19	2.071	5.808	8.941	11.633	16.417	26.851	45.242	62.240	109.826	198.928	368.549	695.649	1015.950
A 20	1.963	5.591	8.680	11.359	16.154	26.717	45.526	63.035	112.575	205.578	383.565	727.987	1066.258
A 27	1.694	4.844	7.537	9.877	14.072	23.335	39.869	55.283	98.786	180.910	338.259	643.197	942.652
A 28	1.955	5.543	8.584	11.215	15.914	26.237	44.566	61.595	109.495	199.618	371.645	704.947	1031.678
A 43	2.198	6.094	9.320	12.074	16.938	27.464	45.859	62.761	109.815	197.415	365.415	682.597	994.072
A 51	2.018	5.658	8.711	11.335	15.997	26.168	44.096	60.669	107.066	193.950	359.557	678.547	990.697
A 52	2.052	5.733	8.807	11.445	16.122	26.301	44.196	60.709	106.859	193.129	357.142	673.106	982.296
A 59	1.767	5.191	8.196	10.841	15.640	26.392	45.872	64.215	116.456	215.981	408.017	782.170	1150.752
A 60	2.087	5.771	8.814	11.409	15.984	25.869	43.111	58.933	102.925	184.719	339.555	636.845	927.184
A 67	2.158	5.958	9.044	11.683	16.325	26.315	43.671	59.554	103.592	185.240	339.447	635.008	923.548
A 68	1.883	5.243	8.038	10.430	14.664	23.854	39.966	54.805	96.201	173.458	320.058	602.188	878.079
B 75	1.956	5.609	8.791	11.574	16.594	27.760	47.845	66.668	120.042	221.284	415.980	794.559	1166.553
B 76	2.125	5.826	8.853	11.421	15.927	25.598	42.548	57.643	99.961	178.249	325.050	608.555	883.729
B 83	1.642	4.661	7.224	9.441	13.404	22.116	37.596	51.984	92.475	168.696	314.406	596.505	872.855
B 84	1.553	4.471	6.983	9.173	13.113	21.846	37.500	52.134	93.541	171.912	322.570	614.400	901.438
B 99	1.968	5.404	8.220	10.610	14.808	23.829	39.475	53.773	95.571	166.694	305.058	569.981	828.527
B100	1.956	5.420	8.288	10.735	15.056	24.402	40.731	55.732	97.480	175.184	322.400	605.247	881.588
B115	1.848	5.115	7.817	10.121	14.189	22.981	38.551	52.426	91.654	164.575	302.716	568.047	827.227
B116	1.922	5.255	7.975	10.278	14.314	22.958	37.898	51.518	89.148	158.656	289.557	559.795	783.586
C124	1.928	5.252	7.952	10.231	14.216	22.722	37.571	50.692	87.400	155.024	282.080	524.607	760.628
C132	1.540	4.223	6.418	8.278	11.544	18.552	30.090	41.773	72.455	129.158	236.094	440.765	640.262
C139	1.604	4.429	6.759	8.744	12.243	19.794	32.952	45.018	78.543	140.852	258.078	484.849	705.671
C140	1.576	3.950	6.111	8.004	11.397	18.884	32.258	44.683	79.787	146.029	272.902	518.714	700.069
C147	1.524	3.616	5.483	7.062	9.828	15.746	25.962	35.269	60.959	108.573	197.590	368.090	534.153
C148	1.565	4.197	6.295	8.048	11.082	17.472	28.308	38.052	64.011	112.968	202.950	373.595	538.487
C155	1.550	3.685	5.587	7.195	10.010	16.031	26.421	35.884	61.998	110.180	200.020	374.008	542.649
C156	1.442	3.895	5.866	7.520	10.397	16.492	26.902	36.310	62.084	109.268	197.464	365.128	527.889
C163	1.153	3.162	4.854	6.305	8.877	14.470	24.294	33.354	58.065	105.949	195.007	368.858	538.164
C172	1.527	3.551	5.318	6.791	9.338	14.687	23.733	31.852	53.954	94.052	168.564	309.496	445.881
C180	1.445	3.911	5.899	7.570	10.481	16.660	27.258	36.814	63.092	111.284	201.496	373.192	539.985
C188	1.053	2.909	4.489	5.850	8.274	13.576	22.950	31.632	55.985	101.677	188.795	357.001	521.820

BLOCK - III

PLOT NO	TIME(MINS) 1.	6.	12.	18.	30.	60.	120.	180.	300.	720.	1440.	2880.	4320.
A 5	1.995	5.696	8.856	11.599	16.516	27.362	46.706	64.730	115.572	211.504	395.255	751.185	1100.674
A 6	1.864	5.343	8.326	10.920	15.578	25.878	44.290	61.475	110.019	201.753	377.047	718.725	1053.782
A 13	1.897	5.454	8.512	11.177	15.967	26.577	45.578	63.332	113.542	208.528	390.613	744.512	1092.105
A 14	1.807	5.216	8.158	10.727	15.353	25.622	44.055	61.306	110.160	202.711	380.520	725.822	1065.551
A 21	1.996	5.701	8.866	11.614	16.540	27.410	46.802	64.874	115.860	212.080	396.585	753.489	1104.150
A 22	2.215	6.152	9.420	12.212	17.149	27.846	46.567	63.788	111.772	201.195	370.784	696.871	1015.603
A 29	2.145	6.076	9.406	12.284	17.425	28.710	48.739	67.340	119.042	218.019	405.965	769.398	1125.855
A 30	2.202	6.160	9.470	12.311	17.352	28.329	47.645	65.478	115.545	208.607	385.990	727.825	1062.590
A 45	2.224	6.075	9.213	11.867	16.515	26.461	45.652	59.275	102.459	182.162	352.141	618.771	897.913
A 46	2.251	6.148	9.323	12.008	16.712	26.776	44.151	59.980	103.678	184.528	336.091	626.128	908.589
B 61	1.850	5.098	7.819	10.148	14.271	23.224	38.928	53.394	93.765	169.105	312.158	587.475	856.727
B 62	1.554	4.478	6.997	9.195	13.149	21.918	37.044	52.350	93.975	172.776	324.098	617.850	906.622
B 69	1.690	4.750	7.274	9.458	13.336	21.784	36.656	50.391	88.808	160.685	297.425	560.980	818.976
B 70	1.843	5.084	7.754	10.028	14.033	22.669	37.707	51.490	89.762	160.851	295.228	553.071	804.763
B 77	1.579	4.714	7.505	9.979	14.495	24.688	43.294	60.898	111.260	207.620	394.168	758.530	1118.001
B 78	1.504	4.025	6.515	8.753	12.883	22.333	39.811	56.491	104.574	197.258	377.700	751.619	1081.626
B 86	1.558	3.962	6.281	8.329	12.056	20.436	35.673	50.056	91.108	169.484	320.960	616.455	907.761
B 94	1.821	4.952	7.492	9.634	13.376	21.355	35.079	47.548	81.878	145.063	265.692	489.999	710.155
B101	1.778	4.827	7.294	9.372	12.998	20.718	33.970	45.995	79.059	159.853	255.607	471.043	682.262
B102	1.858	5.265	8.153	10.650	15.109	24.901	42.284	58.429	103.855	189.254	352.465	668.092	977.661
B109	1.875	5.190	7.932	10.272	14.400	23.326	38.910	53.221	93.055	167.102	307.586	576.844	840.063
B110	1.776	4.901	7.476	9.669	13.531	21.861	36.368	49.665	86.590	155.165	284.655	533.675	776.568
B117	1.809	4.795	7.142	9.086	12.423	19.372	31.002	41.359	69.509	119.654	212.490	387.052	555.575
B118	1.615	4.497	6.896	8.949	12.585	20.478	34.520	47.070	82.047	149.040	275.094	517.681	754.919
C133	1.590	4.346	6.594	8.496	11.829	18.966	31.290	42.534	73.575	130.896	238.606	445.105	646.055
C134	1.540	3.713	5.677	7.354	10.314	16.718	27.906	38.185	66.791	120.037	220.918	414.740	604.117
C142	1.617	4.509	6.920	8.985	12.645	20.598	34.500	47.430	83.567	150.480	277.974	523.441	763.559
C150	1.593	4.279	6.424	8.218	11.327	17.883	29.019	39.046	66.406	116.287	209.204	385.558	556.074
C158	1.161	3.157	4.775	6.139	8.523	13.605	22.344	30.282	52.155	92.552	167.047	311.855	451.941
C165	1.265	3.454	5.189	6.668	9.249	14.744	24.180	32.742	56.289	99.576	180.763	335.519	485.998
C173	1.249	3.425	5.207	6.718	9.371	15.066	24.955	33.946	58.888	105.044	192.080	358.695	521.121
C174	1.459	3.875	5.827	7.462	10.301	16.300	26.518	35.734	60.952	106.964	192.656	355.912	514.065
C182	1.255	3.375	5.071	6.492	8.955	14.156	23.004	30.978	52.761	92.520	160.651	307.295	443.662
C189	1.525	3.624	5.499	7.086	9.867	15.824	26.118	35.503	61.427	109.509	199.462	371.854	559.749

CUMULATIVE INFILTRATION. KYETMAUK-TAUNG CATCHMENT AREA, MT. POPPA TROPICAL FOREST BURMA. DATE : 06/06/78 TIME : 09/55/49 PAGE : 4

BLOCK - IV

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
	TIME(MINS)												
A 8	2.026	5.667	8.712	11.325	15.961	26.058	43.821	60.219	106.072	191.826	354.920	669.205	976.804
A 15	1.994	5.692	8.848	11.587	16.495	27.520	46.022	64.604	115.320	211.000	394.225	749.169	1097.650
A 16	1.780	5.272	8.359	11.086	16.048	27.208	47.504	66.663	121.552	225.773	427.601	621.558	1209.504
A 23	1.826	5.117	7.872	10.240	14.444	23.610	39.754	54.671	96.411	174.557	325.215	609.859	890.486
A 24	2.568	6.638	10.215	13.289	18.749	30.656	51.655	71.021	125.281	226.858	420.194	792.981	1157.967
A 31	2.515	6.406	9.787	12.671	17.758	28.751	47.955	65.546	114.522	205.612	378.084	709.305	1052.812
A 32	2.225	6.122	9.323	12.044	16.829	27.129	43.022	61.397	106.799	190.978	349.966	654.692	951.975
A 39	2.059	5.733	8.791	11.408	16.042	26.101	43.742	59.990	105.526	189.928	350.549	659.649	961.950
A 40	1.793	5.261	8.301	10.976	15.827	26.688	46.554	64.865	117.566	217.929	411.551	788.658	1160.125
A 47	2.012	5.709	8.848	11.564	16.418	27.089	46.049	63.671	115.265	206.615	385.071	730.518	1069.013
B 55	1.699	4.869	7.588	9.953	14.198	23.587	40.575	56.039	100.298	183.954	344.507	655.293	960.796
B 56	1.778	5.087	7.918	10.378	14.791	24.537	41.941	58.172	105.989	190.504	356.297	677.648	993.249
B 63	1.444	4.205	6.608	8.715	12.525	21.022	36.347	50.736	91.606	169.259	318.787	609.670	895.963
B 64	1.564	4.626	7.328	9.714	14.054	23.806	41.530	58.252	105.968	197.056	375.000	716.200	1054.497
B 71	1.763	4.955	7.636	9.944	14.048	23.012	38.855	53.476	94.500	171.591	317.080	600.542	877.411
B 79	1.853	5.116	7.855	10.202	14.361	23.404	39.288	53.934	94.845	171.265	316.478	596.115	869.687
B 87	1.729	4.749	7.225	9.326	13.019	20.954	34.719	47.302	82.152	146.695	268.488	501.758	729.255
B 88	1.527	4.405	6.887	9.052	12.950	21.598	37.114	51.628	92.720	170.540	320.008	610.216	895.521
B103	1.553	4.257	6.467	8.341	11.629	18.683	30.896	42.044	72.885	129.917	237.421	443.140	643.656
B104	1.751	4.845	7.452	9.691	13.665	22.325	37.572	51.654	91.049	164.761	305.002	575.329	859.951
B111	1.675	4.684	7.201	9.360	13.191	21.534	36.210	49.759	87.641	158.486	293.218	552.844	806.942
B112	1.565	4.499	7.023	9.221	13.174	21.929	37.609	52.262	93.701	172.095	322.545	614.479	901.376
B119	1.498	4.141	6.323	8.183	11.463	18.546	30.900	42.234	73.741	132.512	243.170	456.000	663.858
B120	1.724	4.804	7.369	9.566	13.458	21.911	36.744	50.412	88.565	159.793	295.066	555.457	810.143
C127	1.813	4.907	7.400	9.497	13.148	20.899	34.167	46.180	79.142	139.591	252.748	468.111	677.323
C135	1.664	4.529	6.855	8.819	12.251	19.575	32.182	43.642	75.216	133.564	242.592	451.049	653.890
C136	1.769	4.818	7.292	9.382	13.033	20.827	34.245	46.443	80.052	141.954	258.240	480.180	696.148
C144	1.719	4.775	7.312	9.480	13.314	21.623	36.166	49.548	86.857	156.557	288.154	541.635	789.407
C159	1.196	3.281	4.989	6.437	8.980	14.442	23.907	32.553	56.486	100.782	184.525	344.268	500.201
C160	1.325	3.623	5.497	7.084	9.864	15.818	26.100	35.485	61.591	109.257	199.518	371.540	559.517
C175	1.517	4.167	6.340	8.186	11.429	18.399	30.495	41.553	72.188	128.955	236.052	441.182	641.250
C184	1.415	3.751	5.539	7.030	9.581	14.860	23.658	31.414	52.292	89.684	158.296	286.792	410.585
C191	1.155	3.209	4.914	6.371	8.948	14.533	24.509	33.304	58.570	105.091	195.709	364.119	550.696

INFILTRATION RATE.

KYEIMAUK-TAUNG CATCHMENT AREA, MT. PUPPA
******** TROPICAL FOREST ********
BURMA.

DATE : 06/04/78
TIME : 09/56/00

PAGE : 5

BLOCK - I

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
	TIME(MINS)												
A 1	1.107	0.577	0.470	0.423	0.375	0.327	0.293	0.278	0.259	0.245	0.235	0.228	0.225
A 9	1.045	0.540	0.438	0.393	0.347	0.302	0.269	0.255	0.257	0.225	0.214	0.207	0.205
A 10	1.012	0.544	0.449	0.407	0.365	0.323	0.293	0.279	0.262	0.250	0.241	0.235	0.252
A 18	1.082	0.566	0.462	0.416	0.370	0.323	0.290	0.276	0.257	0.243	0.234	0.227	0.224
A 26	1.006	0.555	0.464	0.424	0.383	0.343	0.314	0.301	0.284	0.273	0.264	0.258	0.256
A 34	1.173	0.607	0.492	0.442	0.391	0.340	0.304	0.288	0.267	0.252	0.242	0.254	0.251
A 41	1.112	0.597	0.492	0.446	0.400	0.353	0.320	0.306	0.287	0.273	0.264	0.257	0.254
A 42	1.165	0.599	0.485	0.434	0.383	0.332	0.290	0.280	0.259	0.244	0.234	0.220	0.223
A 49	1.151	0.581	0.466	0.415	0.364	0.312	0.270	0.260	0.259	0.224	0.213	0.206	0.203
A 50	1.099	0.547	0.435	0.386	0.336	0.287	0.251	0.236	0.215	0.201	0.191	0.184	0.180
A 58	0.881	0.467	0.383	0.346	0.309	0.271	0.245	0.233	0.218	0.207	0.199	0.194	0.191
B 65	1.150	0.567	0.454	0.403	0.353	0.302	0.266	0.250	0.229	0.215	0.204	0.197	0.194
B 73	0.843	0.447	0.367	0.331	0.295	0.260	0.234	0.223	0.208	0.198	0.191	0.186	0.183
B 74	0.887	0.447	0.358	0.319	0.279	0.239	0.211	0.199	0.185	0.171	0.163	0.157	0.155
B 81	0.965	0.507	0.415	0.374	0.333	0.291	0.262	0.249	0.232	0.220	0.212	0.206	0.203
B 89	0.984	0.494	0.395	0.351	0.307	0.262	0.231	0.217	0.199	0.186	0.177	0.171	0.168
B 90	0.966	0.480	0.381	0.338	0.294	0.250	0.219	0.205	0.187	0.174	0.165	0.159	0.156
B 97	0.984	0.508	0.412	0.369	0.326	0.283	0.253	0.240	0.222	0.210	0.201	0.195	0.192
B106	1.027	0.500	0.394	0.347	0.299	0.252	0.218	0.203	0.184	0.170	0.160	0.154	0.151
C113	0.856	0.441	0.357	0.320	0.283	0.245	0.219	0.207	0.192	0.181	0.175	0.168	0.165
C121	0.863	0.430	0.342	0.304	0.265	0.226	0.198	0.186	0.170	0.159	0.151	0.145	0.142
C122	0.845	0.426	0.342	0.304	0.267	0.229	0.202	0.190	0.175	0.164	0.156	0.151	0.149
C130	0.747	0.372	0.297	0.263	0.229	0.195	0.171	0.161	0.147	0.137	0.130	0.125	0.123
C137	0.706	0.367	0.298	0.268	0.238	0.207	0.185	0.176	0.163	0.154	0.148	0.144	0.142
C138	0.745	0.385	0.312	0.279	0.247	0.214	0.191	0.181	0.168	0.159	0.152	0.147	0.145
C145	0.674	0.343	0.276	0.246	0.216	0.186	0.165	0.155	0.145	0.135	0.128	0.124	0.122
C153	0.870	0.423	0.332	0.292	0.252	0.212	0.183	0.171	0.154	0.142	0.134	0.128	0.126
C154	0.672	0.357	0.269	0.239	0.209	0.178	0.157	0.147	0.135	0.126	0.120	0.116	0.114
C162	0.556	0.282	0.227	0.202	0.177	0.153	0.135	0.127	0.117	0.110	0.105	0.102	0.100
C170	0.715	0.354	0.282	0.249	0.217	0.184	0.161	0.151	0.138	0.128	0.122	0.117	0.115
C177	0.763	0.359	0.277	0.241	0.205	0.169	0.143	0.131	0.116	0.106	0.098	0.095	0.091
C185	0.613	0.510	0.249	0.222	0.195	0.167	0.148	0.139	0.128	0.120	0.115	0.111	0.109

INFILTRATION RATE. KYETMAUK-TAUNG CATCHMENT AREA, MT. PUPPA DATE : 06/04/78
******** TROPICAL FOREST ******** TIME : 09/56/12
BURMA. PAGE : 6

BLOCK - II

TIME(MINS)

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
A 4	1.088	0.619	0.525	0.483	0.441	0.398	0.308	0.355	0.338	0.326	0.317	0.311	0.308
A 11	1.042	0.555	0.456	0.413	0.369	0.325	0.294	0.280	0.262	0.250	0.241	0.234	0.251
A 12	0.990	0.547	0.457	0.418	0.378	0.338	0.309	0.297	0.280	0.269	0.261	0.255	0.252
A 19	1.139	0.587	0.476	0.427	0.377	0.327	0.292	0.276	0.256	0.242	0.251	0.224	0.221
A 20	1.092	0.576	0.472	0.426	0.379	0.333	0.300	0.285	0.266	0.253	0.243	0.257	0.254
A 27	0.945	0.501	0.412	0.372	0.332	0.292	0.264	0.251	0.255	0.223	0.215	0.209	0.207
A 28	1.084	0.568	0.464	0.418	0.371	0.325	0.292	0.277	0.258	0.245	0.255	0.229	0.226
A 43	1.199	0.608	0.488	0.435	0.382	0.329	0.291	0.274	0.252	0.257	0.226	0.218	0.215
A 51	1.110	0.572	0.464	0.416	0.367	0.319	0.285	0.269	0.250	0.256	0.226	0.219	0.216
A 52	1.125	0.577	0.467	0.418	0.368	0.319	0.284	0.268	0.248	0.254	0.224	0.216	0.213
A 59	1.005	0.554	0.463	0.423	0.382	0.342	0.313	0.300	0.283	0.272	0.265	0.257	0.255
A 60	1.136	0.574	0.460	0.410	0.359	0.308	0.272	0.257	0.256	0.221	0.211	0.205	0.200
A 67	1.171	0.587	0.469	0.416	0.364	0.311	0.274	0.257	0.256	0.220	0.210	0.202	0.199
A 68	1.050	0.526	0.424	0.378	0.333	0.287	0.255	0.241	0.222	0.209	0.200	0.195	0.190
B 75	1.090	0.590	0.488	0.444	0.399	0.353	0.322	0.307	0.289	0.276	0.267	0.260	0.257
B 76	1.150	0.573	0.456	0.405	0.353	0.301	0.264	0.248	0.226	0.211	0.201	0.195	0.190
B 83	0.911	0.478	0.391	0.352	0.313	0.274	0.247	0.234	0.218	0.207	0.199	0.193	0.191
B 84	0.870	0.467	0.385	0.349	0.312	0.276	0.250	0.239	0.224	0.213	0.206	0.201	0.198
B 99	1.066	0.552	0.425	0.377	0.329	0.281	0.247	0.232	0.212	0.198	0.188	0.181	0.178
B100	1.067	0.540	0.434	0.387	0.339	0.292	0.258	0.243	0.224	0.210	0.200	0.194	0.191
B115	1.007	0.509	0.409	0.364	0.319	0.274	0.245	0.229	0.210	0.197	0.188	0.182	0.179
B116	1.058	0.515	0.410	0.363	0.316	0.269	0.255	0.220	0.201	0.187	0.178	0.171	0.168
C124	1.059	0.512	0.406	0.359	0.311	0.264	0.230	0.215	0.196	0.182	0.172	0.166	0.163
C132	0.834	0.415	0.331	0.293	0.256	0.218	0.191	0.179	0.164	0.153	0.145	0.140	0.157
C139	0.872	0.440	0.352	0.313	0.275	0.235	0.208	0.196	0.180	0.168	0.160	0.155	0.152
C140	0.767	0.406	0.333	0.301	0.269	0.236	0.213	0.203	0.190	0.180	0.173	0.169	0.167
C147	0.714	0.354	0.281	0.249	0.216	0.184	0.161	0.151	0.137	0.128	0.121	0.116	0.114
C148	0.834	0.401	0.313	0.275	0.236	0.197	0.169	0.157	0.141	0.130	0.122	0.116	0.114
C155	0.728	0.360	0.286	0.253	0.220	0.187	0.165	0.153	0.159	0.130	0.125	0.118	0.116
C156	0.772	0.375	0.295	0.260	0.224	0.188	0.165	0.152	0.137	0.127	0.119	0.114	0.112
C163	0.621	0.318	0.257	0.230	0.202	0.175	0.156	0.147	0.136	0.128	0.122	0.119	0.117
C172	0.706	0.338	0.264	0.231	0.198	0.165	0.141	0.131	0.117	0.107	0.101	0.096	0.094
C180	0.775	0.378	0.298	0.263	0.227	0.191	0.166	0.155	0.140	0.130	0.122	0.117	0.115
C188	0.570	0.296	0.240	0.216	0.191	0.166	0.149	0.141	0.131	0.124	0.119	0.115	0.114

INFILTRATION RATE. ********KYEIMAUK-TAUNG CATCHMENT AREA, MT. POPPA******** (8) DATE : 08/04/78 TIME : 09/56/18

TROPICAL FOREST

BURMA.

PAGE : 7

BLOCK - III

PLOT NO	TIME(MINS) 1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
A 5	1.111	0.589	0.483	0.436	0.389	0.342	0.309	0.294	0.274	0.261	0.251	0.244	0.241
A 6	1.042	0.555	0.456	0.413	0.369	0.325	0.294	0.280	0.262	0.250	0.241	0.234	0.231
A 13	1.062	0.568	0.468	0.424	0.380	0.335	0.304	0.290	0.271	0.259	0.249	0.245	0.240
A 14	1.015	0.546	0.451	0.409	0.367	0.325	0.295	0.282	0.264	0.252	0.243	0.237	0.235
A 21	1.112	0.589	0.484	0.437	0.390	0.343	0.309	0.295	0.275	0.262	0.252	0.245	0.242
A 22	1.210	0.615	0.495	0.441	0.388	0.334	0.296	0.279	0.257	0.242	0.231	0.225	0.220
A 29	1.188	0.622	0.508	0.457	0.406	0.355	0.319	0.303	0.282	0.267	0.257	0.249	0.246
A 30	1.209	0.621	0.502	0.450	0.397	0.344	0.306	0.290	0.268	0.253	0.242	0.234	0.231
A 45	1.200	0.595	0.472	0.418	0.364	0.309	0.270	0.253	0.231	0.215	0.204	0.196	0.192
A 46	1.215	0.602	0.478	0.423	0.368	0.313	0.273	0.256	0.233	0.217	0.206	0.198	0.195
B 61	1.002	0.511	0.412	0.368	0.324	0.280	0.249	0.235	0.217	0.204	0.195	0.189	0.186
B 62	0.872	0.468	0.386	0.350	0.314	0.277	0.251	0.240	0.225	0.215	0.207	0.202	0.199
B 69	0.928	0.477	0.386	0.346	0.305	0.265	0.236	0.223	0.207	0.195	0.186	0.181	0.178
B 70	1.002	0.504	0.403	0.359	0.314	0.269	0.237	0.223	0.205	0.192	0.183	0.176	0.173
B 77	0.909	0.512	0.432	0.396	0.361	0.325	0.300	0.288	0.274	0.263	0.256	0.251	0.249
B 78	0.769	0.452	0.389	0.360	0.332	0.303	0.283	0.274	0.262	0.254	0.248	0.244	0.242
B 86	0.766	0.427	0.358	0.328	0.297	0.267	0.245	0.235	0.225	0.214	0.208	0.203	0.201
B 94	0.980	0.482	0.382	0.337	0.292	0.247	0.216	0.201	0.183	0.170	0.161	0.154	0.152
B101	0.956	0.469	0.370	0.327	0.283	0.239	0.208	0.194	0.176	0.164	0.155	0.148	0.145
B102	1.050	0.539	0.440	0.396	0.352	0.308	0.277	0.263	0.245	0.232	0.223	0.217	0.214
B109	1.022	0.517	0.415	0.370	0.324	0.279	0.246	0.232	0.213	0.200	0.191	0.184	0.181
B110	0.966	0.486	0.389	0.346	0.303	0.260	0.229	0.216	0.198	0.185	0.176	0.170	0.167
B117	0.956	0.451	0.349	0.304	0.258	0.213	0.180	0.166	0.148	0.134	0.125	0.118	0.116
B118	0.884	0.451	0.364	0.325	0.286	0.247	0.219	0.207	0.191	0.180	0.172	0.166	0.164
C133	0.859	0.426	0.338	0.300	0.261	0.222	0.194	0.182	0.166	0.155	0.147	0.141	0.138
C134	0.731	0.370	0.297	0.265	0.233	0.200	0.177	0.167	0.153	0.144	0.137	0.133	0.131
C142	0.886	0.453	0.366	0.327	0.288	0.249	0.221	0.209	0.193	0.182	0.174	0.168	0.166
C150	0.849	0.410	0.321	0.281	0.242	0.202	0.174	0.162	0.145	0.134	0.126	0.120	0.117
C158	0.625	0.307	0.243	0.215	0.186	0.158	0.137	0.128	0.117	0.108	0.102	0.098	0.096
C165	0.680	0.334	0.264	0.233	0.201	0.170	0.148	0.138	0.126	0.116	0.110	0.106	0.104
C173	0.676	0.337	0.269	0.238	0.208	0.177	0.155	0.146	0.133	0.125	0.118	0.114	0.112
C174	0.769	0.372	0.292	0.257	0.221	0.185	0.160	0.149	0.134	0.124	0.116	0.111	0.109
C182	0.670	0.324	0.254	0.223	0.192	0.160	0.138	0.128	0.116	0.107	0.100	0.096	0.094
C189	0.716	0.355	0.282	0.250	0.218	0.185	0.162	0.152	0.159	0.129	0.122	0.118	0.116

INFILTRATION RATE.

KYEINDAUK-TAUNG CATCHMENT AREA, MT. PUPPA
TROPICAL FOREST
BURMA.

DATE : 86/06/28
TIME : 09/58/23

BLOCK - IV

TIME(MINS)

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
A 8	1.112	0.571	0.462	0.414	0.365	0.316	0.282	0.266	0.246	0.252	0.222	0.215	0.212
A 15	1.111	0.588	0.482	0.435	0.389	0.341	0.308	0.293	0.274	0.260	0.250	0.244	0.241
A 16	1.019	0.568	0.477	0.436	0.396	0.355	0.326	0.314	0.297	0.285	0.277	0.271	0.268
A 23	1.004	0.517	0.410	0.375	0.331	0.287	0.256	0.242	0.224	0.212	0.203	0.196	0.194
A 24	1.302	0.671	0.543	0.487	0.430	0.373	0.333	0.315	0.292	0.275	0.264	0.255	0.252
A 31	1.261	0.637	0.511	0.455	0.399	0.343	0.303	0.286	0.265	0.246	0.235	0.227	0.223
A 32	1.207	0.605	0.483	0.429	0.375	0.321	0.282	0.265	0.243	0.227	0.216	0.208	0.205
A 39	1.127	0.575	0.463	0.414	0.365	0.315	0.279	0.264	0.243	0.229	0.219	0.212	0.208
A 40	1.019	0.561	0.468	0.427	0.386	0.345	0.316	0.303	0.286	0.274	0.265	0.259	0.257
A 47	1.116	0.586	0.479	0.431	0.384	0.336	0.302	0.287	0.267	0.254	0.244	0.237	0.234
B 55	0.949	0.506	0.416	0.376	0.336	0.296	0.268	0.255	0.239	0.228	0.219	0.214	0.211
B 56	0.992	0.527	0.433	0.391	0.350	0.307	0.278	0.265	0.247	0.235	0.227	0.221	0.218
B 63	0.816	0.445	0.369	0.336	0.303	0.269	0.246	0.235	0.221	0.212	0.205	0.200	0.198
B 64	0.894	0.497	0.417	0.382	0.346	0.310	0.285	0.274	0.259	0.249	0.241	0.236	0.234
B 71	0.971	0.502	0.408	0.366	0.324	0.281	0.251	0.238	0.221	0.209	0.200	0.194	0.191
B 79	1.005	0.514	0.415	0.371	0.327	0.283	0.252	0.238	0.220	0.207	0.198	0.192	0.189
B 87	0.957	0.468	0.373	0.331	0.289	0.247	0.217	0.204	0.186	0.174	0.166	0.159	0.157
B 88	0.857	0.461	0.380	0.345	0.309	0.273	0.248	0.237	0.222	0.212	0.205	0.199	0.197
B103	0.840	0.418	0.333	0.295	0.257	0.219	0.192	0.180	0.165	0.154	0.146	0.141	0.138
B104	0.951	0.489	0.396	0.355	0.313	0.271	0.242	0.229	0.212	0.200	0.191	0.185	0.183
B111	0.919	0.472	0.382	0.342	0.302	0.261	0.233	0.220	0.204	0.192	0.184	0.178	0.175
B112	0.876	0.469	0.386	0.350	0.313	0.277	0.251	0.239	0.224	0.213	0.206	0.201	0.198
B119	0.815	0.412	0.330	0.294	0.257	0.221	0.195	0.184	0.169	0.158	0.151	0.146	0.143
B120	0.944	0.482	0.389	0.348	0.306	0.264	0.235	0.222	0.205	0.193	0.184	0.178	0.176
C127	0.972	0.474	0.374	0.329	0.285	0.240	0.208	0.194	0.176	0.163	0.153	0.147	0.144
C135	0.896	0.441	0.350	0.309	0.268	0.227	0.198	0.185	0.168	0.157	0.148	0.142	0.140
C136	0.953	0.470	0.372	0.329	0.285	0.242	0.211	0.197	0.179	0.167	0.158	0.152	0.149
C144	0.959	0.477	0.384	0.343	0.301	0.260	0.230	0.217	0.200	0.188	0.180	0.174	0.171
C159	0.647	0.323	0.257	0.228	0.199	0.170	0.149	0.140	0.128	0.120	0.114	0.109	0.107
C160	0.716	0.355	0.282	0.250	0.218	0.185	0.162	0.152	0.138	0.129	0.122	0.118	0.116
C175	0.822	0.411	0.328	0.291	0.254	0.217	0.191	0.179	0.164	0.153	0.146	0.140	0.138
C184	0.745	0.348	0.268	0.233	0.197	0.161	0.136	0.125	0.110	0.100	0.092	0.087	0.085
C191	0.651	0.321	0.258	0.230	0.203	0.175	0.155	0.146	0.135	0.126	0.121	0.117	0.115

CUMULATIVE INFILTRATION.

KYETMAUK-TAUNG CATCHMENT AREA, MT. POPPA
$$$$$ WET SEASON RESULTS $$$$$$$$$
$$$BURMA.$$$

(9)

DATE : 05/04/78
TIME : 17/21/26
PAGE : 1

BLOCK - I

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
	TIME(MINS)												
A 1	1.297	3.237	4.637	5.735	7.518	10.927	16.043	20.204	30.344	46.455	72.784	117.103	156.739
A 9	1.207	3.009	4.307	5.324	6.972	10.118	14.826	18.644	27.916	42.579	66.416	106.327	141.877
A 34	1.399	3.489	4.997	6.180	8.099	11.768	17.272	21.745	32.639	49.933	78.166	125.643	168.070
A 49	1.327	3.303	4.723	5.833	7.629	11.045	16.133	20.241	30.165	45.738	70.841	112.500	149.358
A 58	1.007	2.517	3.607	4.463	5.854	8.520	12.531	15.799	23.788	36.530	57.440	92.789	124.503
B 65	1.627	4.036	5.758	7.099	9.260	13.345	19.372	24.195	35.715	53.503	81.653	127.453	167.355
B 89	1.224	3.042	4.344	5.359	7.000	10.110	14.720	18.425	27.322	41.169	63.284	99.619	131.520
B 90	1.301	3.231	4.614	5.693	7.435	10.738	15.632	19.565	29.008	43.702	67.160	105.692	139.513
B 97	1.271	3.163	4.524	5.587	7.310	10.589	15.478	19.429	28.985	44.006	68.265	108.604	144.348
B106	1.458	3.609	5.143	6.335	8.253	11.865	17.166	21.387	31.405	46.734	70.731	109.307	142.594
C137	1.107	2.753	3.934	4.857	6.349	9.182	13.394	16.787	24.964	37.750	58.279	92.204	122.122
C145	1.123	2.789	3.981	4.911	6.411	9.253	13.459	16.834	24.924	37.484	57.480	90.231	118.913
C170	1.112	2.758	3.933	4.848	6.322	9.106	13.209	16.488	24.308	36.359	55.584	86.254	113.091
C177	1.132	2.801	3.989	4.912	6.394	9.179	13.255	16.492	24.146	35.792	53.908	82.816	107.612
C185	0.997	2.475	3.533	4.358	5.690	8.212	11.943	14.938	22.117	33.260	51.001	80.056	105.500

CUMULATIVE INFILTRATION.

KYETMAUK-TAUNG CATCHMENT AREA, MT. POPPA
$$$$$ WET SEASON RESULTS $$$$$$$$$
$$$BURMA.$$$

BLOCK - II

TIME(MINS)

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
A 19	1.363	3.398	4.865	6.013	7.876	11.432	16.754	21.071	31.560	48.154	75.144	120.357	160.645
A 28	1.320	3.287	4.704	5.812	7.608	11.032	16.146	20.286	30.524	46.153	71.807	114.625	152.674
A 60	1.463	3.635	5.191	6.405	8.365	12.081	17.588	22.013	32.639	49.174	75.574	118.940	157.007
A 67	1.526	3.789	5.408	6.670	8.706	12.560	18.258	22.828	33.770	50.731	77.692	121.767	160.310
A 68	1.427	3.544	5.060	6.243	8.153	11.772	17.134	21.440	31.776	47.848	73.488	115.568	152.481
B 75	1.385	3.447	4.929	6.088	7.964	11.536	16.859	21.160	31.559	47.899	74.277	118.119	156.953
B 76	1.445	3.588	5.122	6.319	8.249	11.905	17.314	21.655	32.059	48.206	73.909	115.996	152.846
B 83	1.246	3.101	4.435	5.478	7.167	10.381	15.174	19.046	28.412	43.153	66.904	106.425	141.442
B100	1.547	3.843	5.488	6.771	8.842	12.768	18.584	23.257	34.471	51.913	79.743	125.426	165.506
B116	1.516	3.765	5.374	6.628	8.653	12.487	18.159	22.709	33.612	50.530	77.449	121.507	160.072
C124	1.231	3.061	4.373	5.397	7.053	10.195	14.861	18.617	27.657	41.770	64.387	101.685	134.527
C132	1.132	2.813	4.017	4.957	6.475	9.354	13.622	17.053	25.298	38.138	58.659	92.404	122.050
C148	1.108	2.746	3.916	4.827	6.293	9.062	13.139	16.395	24.156	36.103	54.937	85.453	111.951
C156	1.066	2.644	3.772	4.651	6.068	8.747	12.700	15.865	23.428	35.114	53.024	83.764	110.042
C188	0.819	2.034	2.904	3.582	4.678	6.752	9.825	12.289	18.201	27.385	42.019	66.003	87.020

CUMULATIVE INFILTRATION.

KYETMAUK-TAUNG CATCHMENT AREA, MT. PUPPA
$$$$$ WET SEASON RESULTS $$$$$$$$
$$$BURMA $$$

DATE : 05/04/78
TIME : 17/21/43

BLOCK - III

TIME(MINS)

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
A 6	1.217	3.034	4.344	5.371	7.036	10.215	14.977	18.842	28.239	43.120	67.349	107.983	144.222
A 14	1.134	2.834	4.063	5.028	6.598	9.607	14.138	17.834	26.876	41.319	65.056	105.246	141.346
A 22	1.628	4.041	5.766	7.111	9.280	13.382	19.441	24.296	35.910	53.884	82.404	128.936	169.567
A 29	1.218	3.046	4.371	5.413	7.109	10.368	15.291	19.319	29.209	45.082	71.505	115.940	156.187
A 46	1.606	3.992	5.702	7.038	9.196	13.291	19.369	24.261	36.029	54.389	83.793	132.251	174.895
B 69	1.512	3.265	4.668	5.764	7.538	10.912	15.935	19.988	29.776	45.125	69.848	110.842	147.089
B 70	1.563	3.394	4.855	5.999	7.851	11.381	16.651	20.915	31.244	47.517	73.863	117.786	156.783
B 94	1.610	3.992	5.692	7.016	9.148	13.173	19.100	23.835	35.121	52.495	79.890	124.285	162.840
B109	1.280	3.192	4.569	5.648	7.398	10.738	15.738	19.794	29.648	45.239	70.600	113.087	150.949
B117	1.619	4.003	5.698	7.013	9.125	13.089	18.879	23.469	34.297	50.718	76.154	116.556	151.075
C133	1.440	3.571	5.092	6.275	8.182	11.780	17.078	21.309	31.390	46.901	71.348	110.939	145.305
C173	1.119	2.776	3.961	4.885	6.374	9.190	13.547	16.677	24.640	36.955	56.480	88.310	116.084
C174	1.332	3.297	4.698	5.787	7.539	10.837	15.677	19.531	28.676	42.662	64.551	99.724	130.064
C182	1.021	2.530	3.607	4.445	5.794	8.338	12.080	15.065	22.170	33.083	50.245	77.974	101.999
C189	1.419	3.511	5.002	6.159	8.021	11.522	16.653	20.733	30.396	45.138	68.137	104.964	136.640

CUMULATIVE INFILTRATION.

KYETMAUK-TAUNG CATCHMENT AREA, MT. PUPPA
$$$$$ WET SEASON RESULTS $$$$$$$$$
$$$BURMA.$$$

DATE : 05/04/78
TIME : 17/21/50
PAGE : 4

BLOCK - IV

TIME(MINS)

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
A 8	1.570	3.902	5.572	6.876	8.982	12.974	18.895	23.651	35.082	52.882	81.524	128.085	169.158
A 15	1.425	3.555	5.092	6.297	8.253	11.993	17.603	22.164	33.274	50.916	79.725	128.185	171.501
A 23	1.371	3.411	4.875	6.019	7.869	11.385	16.614	20.830	30.998	46.916	72.507	114.856	152.243
A 31	1.894	4.704	6.716	8.284	10.817	15.614	22.714	28.413	42.080	63.306	97.121	152.533	201.083
A 40	1.346	3.351	4.792	5.920	7.745	11.220	16.402	20.591	30.722	46.653	72.588	115.194	153.133
B 71	1.373	3.418	4.890	6.041	7.905	11.458	16.759	21.047	31.431	47.783	74.239	118.318	157.434
B 79	1.549	3.848	5.495	6.779	8.853	12.784	18.606	23.283	34.509	51.967	79.819	125.534	165.638
B103	1.301	3.229	4.608	5.683	7.419	10.702	15.557	19.450	28.771	43.219	66.183	103.719	136.542
B119	1.279	3.174	4.530	5.586	7.290	10.514	15.277	19.093	28.225	42.363	64.802	101.429	133.421
B120	1.354	3.371	4.821	5.955	7.791	11.287	16.500	20.713	30.906	46.934	72.828	115.901	154.078
C127	1.252	3.109	4.438	5.474	7.146	10.312	14.994	18.750	27.751	41.713	63.925	100.274	132.085
C136	1.234	3.065	4.377	5.400	7.053	10.185	14.825	18.554	27.504	41.427	63.648	100.134	132.151
C160	1.039	2.581	3.686	4.549	5.942	8.584	12.502	15.651	23.221	35.011	53.657	84.854	112.089
C175	1.168	2.904	4.148	5.118	6.687	9.663	14.076	17.626	26.161	39.464	60.745	95.776	126.577
C184	1.212	2.997	4.265	5.249	6.828	9.789	14.111	17.533	25.597	37.803	56.667	86.550	112.026

KYETMAUK-TAUNG CATCHMENT AREA, MT. POPPA
$$$$$ WET SEASON RESULTS $$$$$$$$$
$$$BURMA,$$$

DATE : 05/04/78
TIME : 17/21/55
PAGE : 5

INFILTRATION RATE.

BLOCK - I

TIME(MINS)

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
A 1	0.657	0.278	0.202	0.168	0.134	0.099	0.075	0.065	0.051	0.041	0.034	0.029	0.027
A 9	0.611	0.258	0.187	0.155	0.124	0.092	0.069	0.059	0.046	0.037	0.030	0.026	0.024
A 34	0.708	0.300	0.217	0.181	0.144	0.107	0.081	0.069	0.054	0.044	0.036	0.031	0.028
A 49	0.671	0.283	0.204	0.169	0.134	0.099	0.075	0.064	0.049	0.039	0.032	0.027	0.025
A 58	0.511	0.217	0.157	0.131	0.104	0.078	0.059	0.051	0.040	0.032	0.027	0.023	0.021
B 65	0.821	0.343	0.247	0.204	0.161	0.118	0.088	0.074	0.057	0.044	0.035	0.029	0.026
B 89	0.618	0.259	0.187	0.155	0.123	0.090	0.067	0.057	0.044	0.035	0.028	0.023	0.021
B 90	0.657	0.276	0.199	0.164	0.130	0.096	0.071	0.061	0.047	0.037	0.030	0.025	0.022
B 97	0.642	0.271	0.196	0.162	0.129	0.095	0.072	0.061	0.047	0.038	0.031	0.026	0.024
B106	0.734	0.306	0.220	0.181	0.143	0.104	0.077	0.065	0.049	0.038	0.030	0.024	0.022
C137	0.559	0.235	0.170	0.141	0.112	0.082	0.062	0.052	0.040	0.032	0.026	0.022	0.020
C145	0.567	0.238	0.171	0.142	0.112	0.082	0.061	0.052	0.040	0.031	0.025	0.021	0.019
C170	0.561	0.235	0.169	0.139	0.110	0.081	0.060	0.050	0.038	0.030	0.024	0.020	0.018
C177	0.570	0.237	0.170	0.140	0.110	0.080	0.059	0.050	0.037	0.029	0.023	0.018	0.016
C185	0.503	0.211	0.152	0.126	0.100	0.073	0.054	0.046	0.035	0.028	0.022	0.019	0.017

INFILTRATION RATE.

KYETMAUK-TAUNG CATCHMENT AREA, MT. POPPA
$$$$$ WET SEASON RESULTS $$$$$$$$$
$$$BURMA.$$$

BLOCK - II

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
	TIME(MINS)												
A 19	0.690	0.292	0.211	0.175	0.140	0.104	0.078	0.067	0.052	0.042	0.034	0.029	0.027
A 28	0.668	0.282	0.204	0.169	0.135	0.100	0.075	0.064	0.050	0.040	0.033	0.028	0.025
A 60	0.739	0.310	0.223	0.185	0.147	0.108	0.080	0.068	0.052	0.041	0.033	0.028	0.025
A 67	0.770	0.323	0.232	0.192	0.152	0.112	0.083	0.070	0.054	0.042	0.034	0.028	0.026
A 68	0.720	0.302	0.218	0.180	0.143	0.105	0.078	0.066	0.051	0.040	0.032	0.027	0.025
B 75	0.700	0.295	0.213	0.177	0.140	0.104	0.078	0.067	0.052	0.041	0.034	0.028	0.026
B 76	0.729	0.306	0.220	0.182	0.144	0.106	0.079	0.067	0.051	0.040	0.032	0.027	0.024
B 83	0.630	0.265	0.192	0.159	0.126	0.094	0.070	0.060	0.046	0.037	0.030	0.025	0.023
B100	0.781	0.328	0.236	0.196	0.155	0.114	0.085	0.072	0.055	0.044	0.035	0.029	0.027
B116	0.765	0.321	0.231	0.191	0.151	0.111	0.083	0.070	0.054	0.042	0.034	0.028	0.026
C124	0.622	0.261	0.188	0.156	0.124	0.091	0.068	0.058	0.045	0.035	0.029	0.024	0.022
C132	0.572	0.240	0.173	0.143	0.114	0.084	0.062	0.053	0.041	0.032	0.026	0.022	0.020
C148	0.558	0.233	0.168	0.139	0.109	0.080	0.059	0.050	0.038	0.030	0.024	0.019	0.018
C156	0.538	0.225	0.162	0.134	0.106	0.078	0.058	0.049	0.037	0.029	0.023	0.019	0.017
C188	0.413	0.173	0.125	0.103	0.082	0.060	0.045	0.038	0.029	0.023	0.018	0.015	0.014

APPENDIX 5.9
Sheet 15 of 16

INFILTRATION RATE.

KYETMAUK-TAUNG CATCHMENT AREA, MT. POPPA
$$$$$ WET SEASON RESULTS $$$$$$$$$
$$$BURMA.$$$

DATE : 05/04/78
TIME : 17/22/05
PAGE : 7

BLOCK - III

PLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
	TIME(MINS)												
A 6	0.616	0.260	0.189	0.157	0.125	0.093	0.070	0.060	0.047	0.057	0.031	0.026	0.024
A 14	0.575	0.244	0.177	0.148	0.118	0.088	0.067	0.057	0.045	0.057	0.030	0.026	0.024
A 22	0.822	0.344	0.248	0.205	0.162	0.119	0.088	0.075	0.057	0.045	0.036	0.030	0.027
A 29	0.618	0.263	0.191	0.159	0.127	0.095	0.073	0.063	0.050	0.040	0.034	0.029	0.027
A 46	0.811	0.341	0.246	0.204	0.161	0.119	0.089	0.076	0.058	0.046	0.037	0.031	0.028
B 69	0.663	0.279	0.202	0.167	0.133	0.098	0.074	0.063	0.049	0.058	0.031	0.026	0.024
B 70	0.689	0.291	0.210	0.175	0.139	0.103	0.077	0.066	0.051	0.041	0.034	0.028	0.026
B 94	0.812	0.339	0.244	0.202	0.159	0.116	0.086	0.073	0.055	0.043	0.034	0.028	0.026
B109	0.648	0.274	0.198	0.165	0.131	0.097	0.073	0.063	0.049	0.039	0.032	0.027	0.025
B117	0.815	0.339	0.243	0.200	0.157	0.114	0.084	0.070	0.053	0.040	0.032	0.025	0.023
C133	0.726	0.304	0.218	0.180	0.142	0.104	0.077	0.065	0.050	0.039	0.031	0.025	0.023
C173	0.564	0.236	0.170	0.141	0.111	0.082	0.061	0.051	0.039	0.031	0.025	0.020	0.018
C174	0.671	0.280	0.201	0.166	0.131	0.095	0.070	0.059	0.045	0.035	0.027	0.022	0.020
C182	0.515	0.215	0.154	0.128	0.101	0.074	0.054	0.046	0.035	0.027	0.022	0.018	0.016
C189	0.714	0.298	0.213	0.176	0.139	0.101	0.074	0.063	0.047	0.036	0.029	0.023	0.021

INFILTRATION RATE.

KYETMAUK-TAUNG CATCHMENT AREA, MT. POPPA
$$$$$ WET SEASON RESULTS $$$$$$$$$
$$$BURMA,$$$

DATE : 05/04/78
TIME : 17/22/08
PAGE : 8

BLOCK - IV

IPLOT NO	1.	6.	12.	18.	30.	60.	120.	180.	360.	720.	1440.	2880.	4320.
	TIME(MINS)												
A 8	0.793	0.333	0.240	0.199	0.157	0.116	0.086	0.073	0.056	0.044	0.036	0.030	0.027
A 15	0.722	0.305	0.221	0.184	0.147	0.109	0.082	0.071	0.055	0.045	0.037	0.031	0.029
A 23	0.693	0.292	0.210	0.174	0.138	0.102	0.077	0.065	0.050	0.040	0.032	0.027	0.025
A 31	0.956	0.401	0.289	0.239	0.189	0.139	0.104	0.088	0.067	0.053	0.043	0.035	0.032
A 40	0.681	0.287	0.207	0.172	0.137	0.101	0.076	0.065	0.050	0.040	0.033	0.028	0.025
B 71	0.694	0.293	0.212	0.176	0.140	0.103	0.078	0.066	0.052	0.041	0.034	0.028	0.026
B 79	0.782	0.328	0.236	0.196	0.155	0.114	0.085	0.072	0.055	0.044	0.035	0.029	0.027
B103	0.656	0.275	0.198	0.164	0.130	0.095	0.071	0.060	0.046	0.036	0.029	0.024	0.022
B119	0.645	0.270	0.195	0.161	0.127	0.093	0.069	0.059	0.045	0.035	0.028	0.025	0.021
B120	0.685	0.289	0.209	0.173	0.137	0.102	0.076	0.065	0.051	0.040	0.033	0.028	0.025
C127	0.632	0.265	0.191	0.158	0.125	0.092	0.068	0.058	0.044	0.035	0.028	0.023	0.021
C136	0.623	0.261	0.188	0.156	0.124	0.091	0.068	0.058	0.044	0.035	0.028	0.023	0.021
C160	0.524	0.220	0.159	0.131	0.104	0.077	0.057	0.049	0.037	0.029	0.024	0.020	0.018
C175	0.590	0.248	0.179	0.148	0.117	0.086	0.065	0.055	0.042	0.033	0.027	0.022	0.021
C184	0.610	0.254	0.182	0.150	0.118	0.085	0.063	0.053	0.039	0.030	0.023	0.019	0.017

APPENDIX 5.10

KYETMAUK-TAUNG CATCHMENT STUDIES

ANALYSIS OF VARIANCE

("F" Test)

Results for cumulative infiltration: dry season

Source of variation	Degree of freedom	Sum of squares	Mean squares	F (Variance ratio)
Blocks	3	0.0050622	0.0016874	0.20513182 NS
Treatments	2	0.6766155	0.33830775	41.1269941 **
Error	6	0.04935558	0.00822593	
Total	11	0.73103328	0.06645757	

"F" Value

$F(2,6) = (P_r\ 0.05)\ 5.14$ $(P_r\ 0.001)\ 10.92$

$F(3,6) = (P_r\ 0.05)\ 4.76$ $(P_r\ 0.01)\ 9.78$

Level of significance ** Highly significant (P_r 0.01)

* Significant (P_r 0.05)

NS Not significant

APPENDIX 5.11

KYETMAUK-TAUNG CATCHMENT STUDIES

SIGNIFICANT DIFFERENCE BETWEEN INDIVIDUAL TREATMENTS

(Student's 't' test)

Results for cumulative infiltration: dry season

Treat-ment	Av. infiltration Sum	Mean	Treatment between	Difference	Level of significance
A	7.9954	1.9989	A & B	0.2476	**
B	7.0052	1.7513	B & C	0.3320	**
C	5.6773	1.4193	C & A	0.5796	**

** = Highly significant (P_r 0.01)
* = Significant (P_r 0.05)

Significant difference between two means = $\sqrt{2}$. SE . t

Student's t

(6 df) = 2.447 (P_r 0.05)

= 3.707 (P_r 0.01)

= 0.1110 (P_r 0.05)

= 0.1681 (P_r 0.01)

APPENDIX 5.12

KYETMAUK-TAUNG CATCHMENT STUDIES

Analysis of Results for Sorptivity : Dry Season

'F' test

Source	SS	DF	MS	F
Site	5.2010	2	2.6005	72.04**
Residual	4.696	130	.0361	
Total	9.897	132		

't' test

Treatment	't' value	Level of significance
A & B	5.41	*
A & C	11.98	**
B & C	6.51	**

APPENDIX 5.13

KYETMAUK-TAUNG CATCHMENT STUDIES

Analysis of Results for Hydraulic Conductivity : Dry Season

'F' test

Source	SS	DF	MS	F
Site	1.6821	2	.8411	158.70**
Residual	0.6939	130	.0053	
Total	2.376			

't' test

Treatment	't' value	Level of significance
A & B	7.21	**
A & C	17.66	**
B & C	10.33	**

KYETMAUK-TAUNG CATCHMENT STUDIES

Analysis of Results for Cumulative Infiltration at 1 min.

Dry Season

'F' test

Source	SS	DF	MS	F
Site	7.5010	2	3.7505	104.88**
Residual	4.649	130	.03576	
Total	12.15	132		

't' test

Treatment	't' value	Level of significance
A & B	6.56	*
A & C	14.46	**
B & C	7.83	**

KYETMAUK-TAUNG CATCHMENT STUDIES

Statistical Analysis of Field Measurements : Wet Season

Basis of comparison : Cumulative infiltration after 1 min.

Treatment	Average cumulative infiltration					
	Block				Treatment Total	Treatment Mean
	I	II	III	IV		
A	1.387	1.554	1.504	1.668	6.114	1.529
B	1.492	1.558	1.562	1.496	6.108	1.527
C	1.182	1.162	1.357	1.277	4.978	1.244
Total	4.061	4.273	4.424	4.442	17.200	
Mean	1.354	1.424	1.475	1.480		1.433

Analysis of Variance

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F
Blocks	3	0.0310	0.0103	1.6067 NS
Treatments	2	0.2139	0.1070	16.7109 **
Error	6	0.0386	0.0064	
Total	11	0.2835		

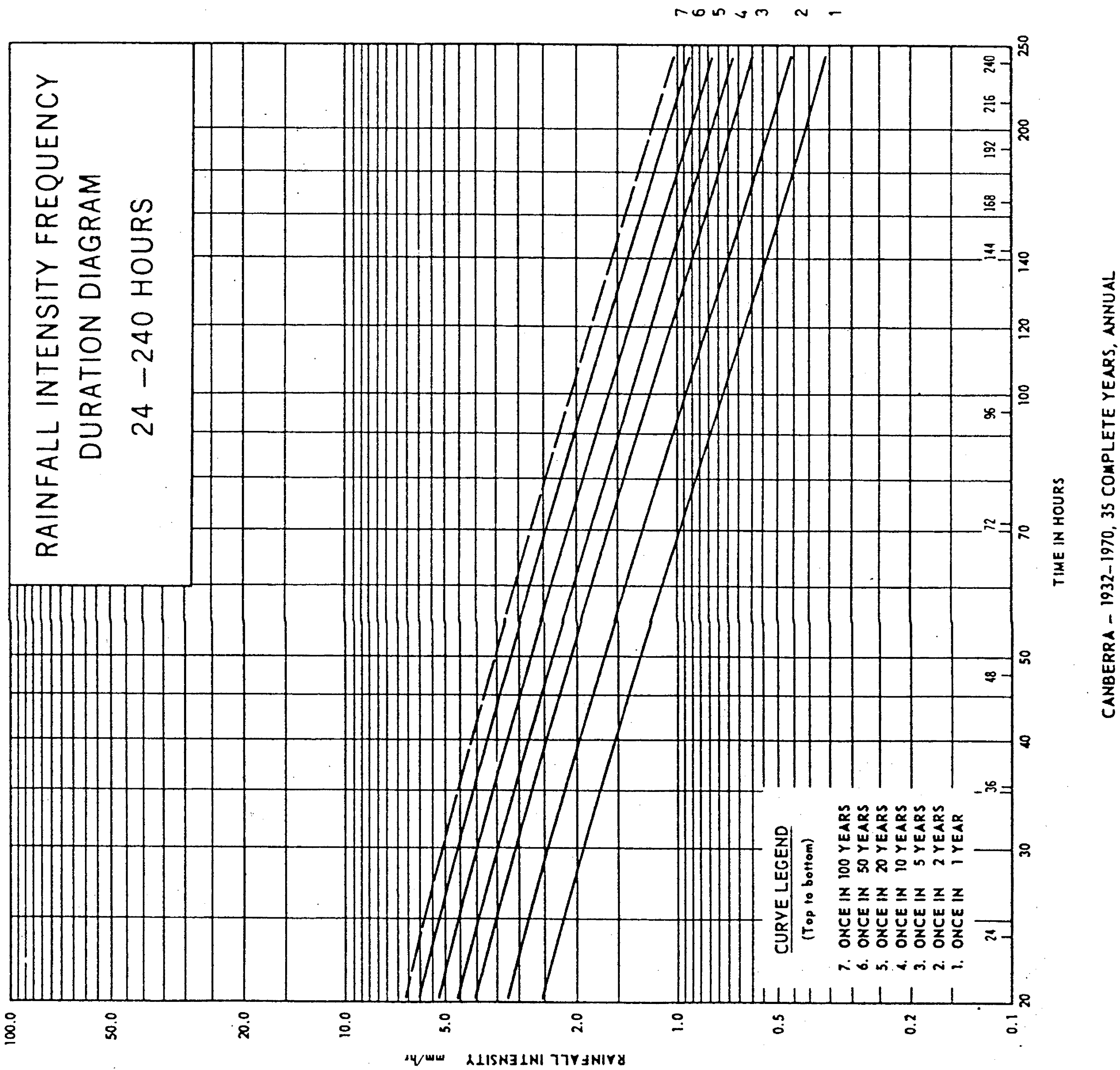
Analysis for Difference between Treatments

't' test

Treatment	Av. infiltration mean	Comparison	Difference	Level of significance
A	1.529	A & B	0.0015	NS
		A & C	0.2838	**
B	1.527	B & C	0.2824	**

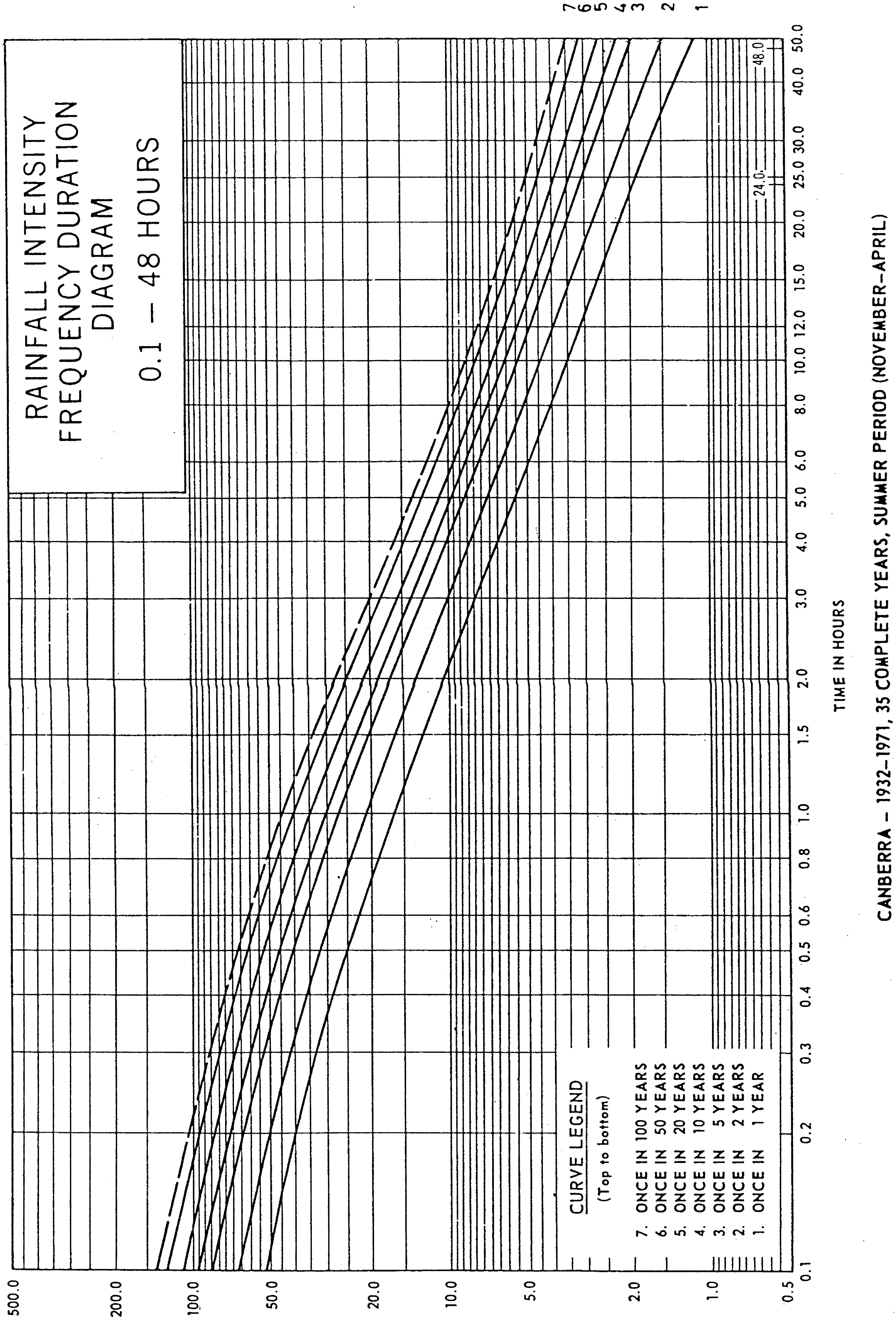
Significant difference between two means = $\sqrt{2}$. SE. t
= 0.0341 t

	5%	1%
Σ(df=6)	0.447	3.707



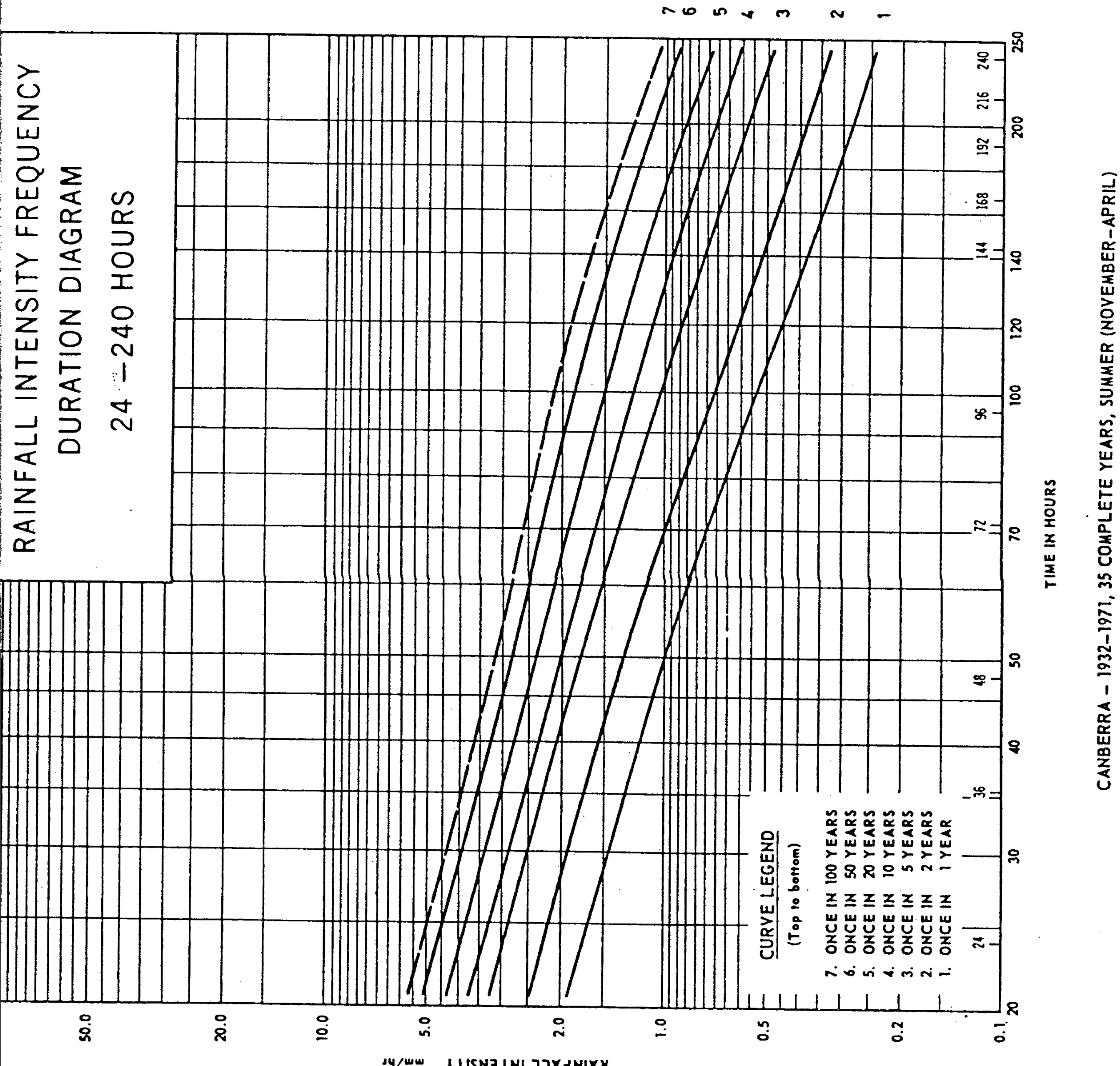
Source: Pierrehumbert (1974)

APPENDIX 6.1
Sheet 2 of 5

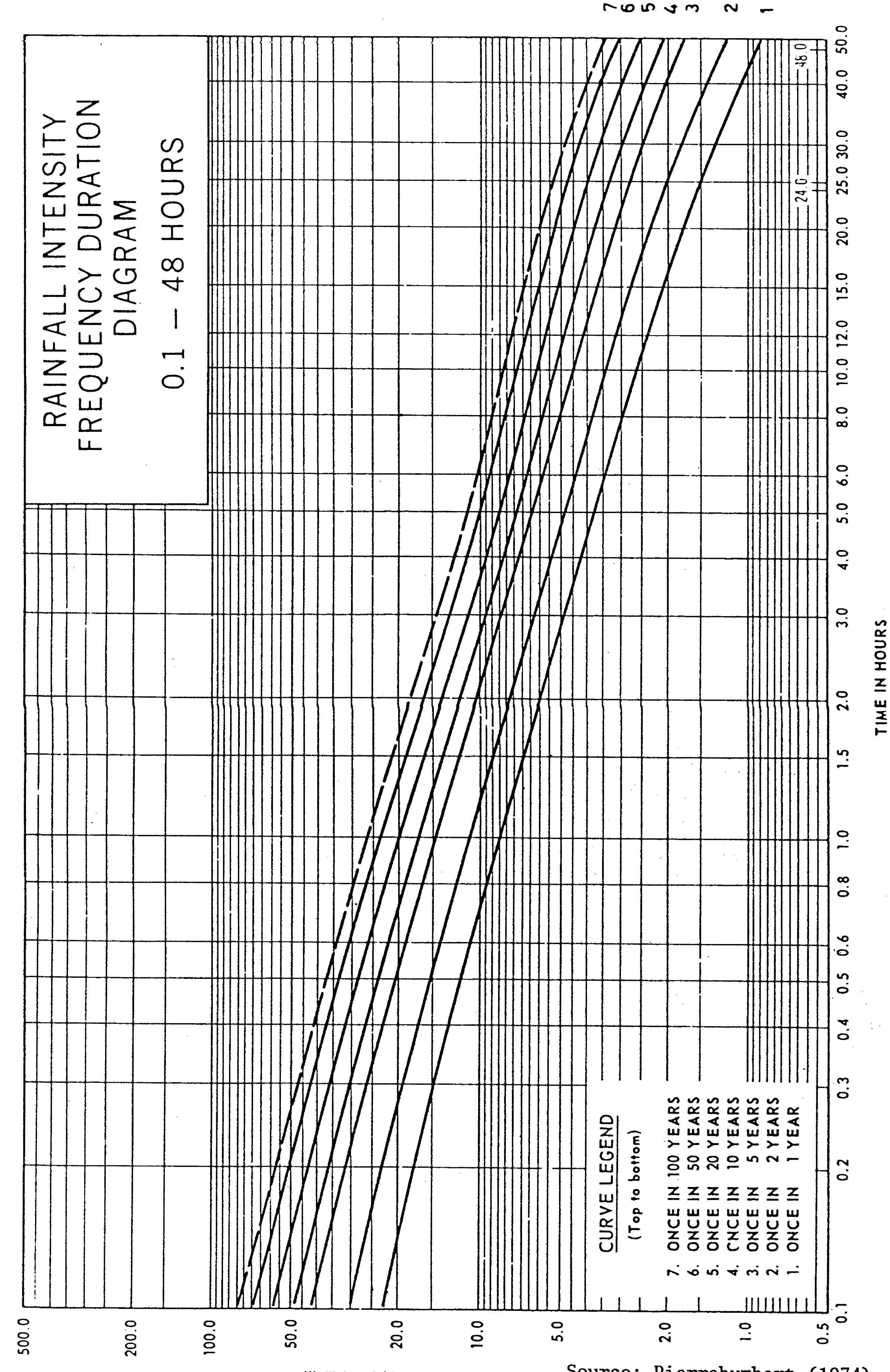


Source: Pierrehumbert (1974)

APPENDIX 6.1
Sheet 3 of 5

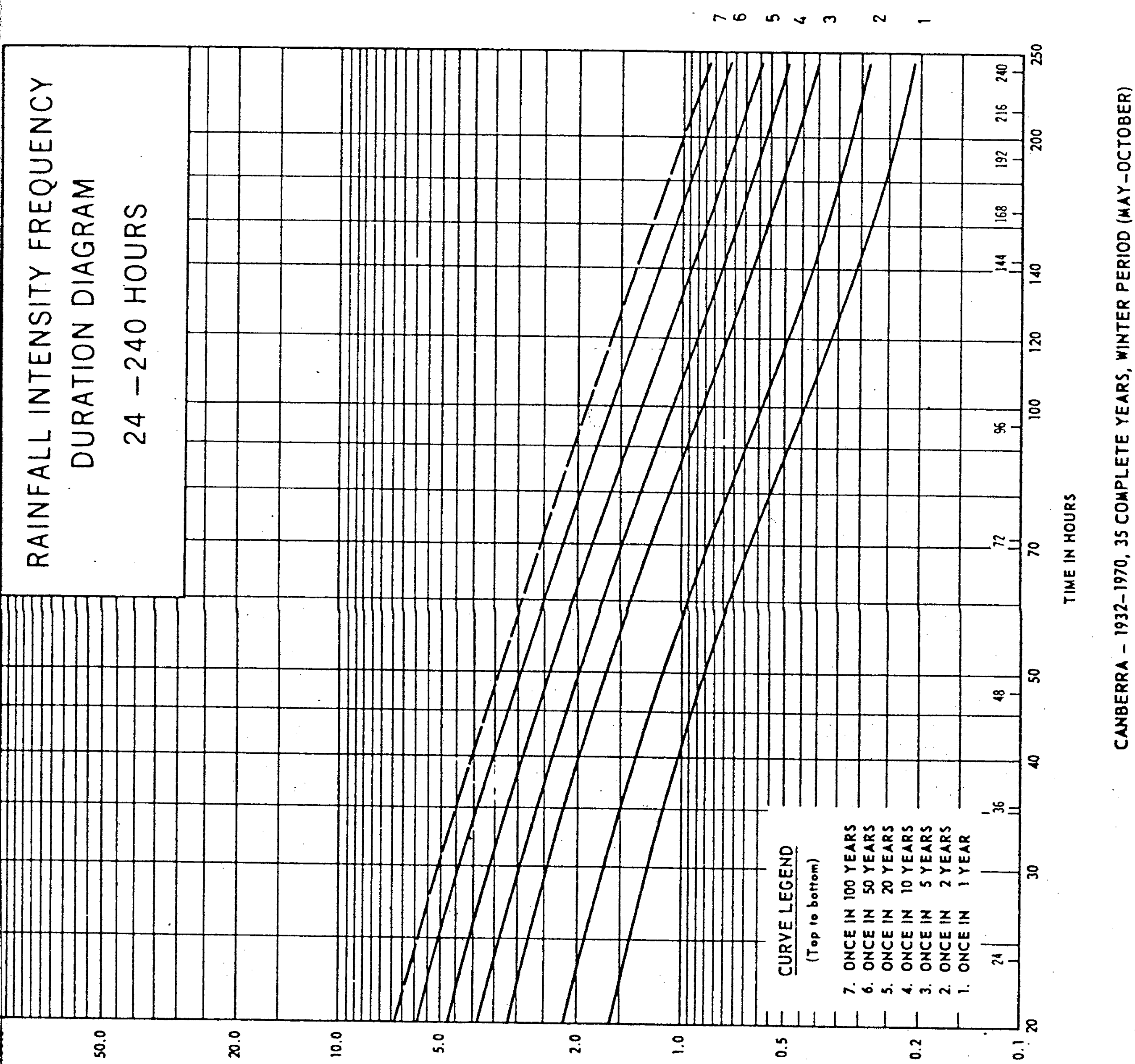


Source: Pierrehumbert (1974)



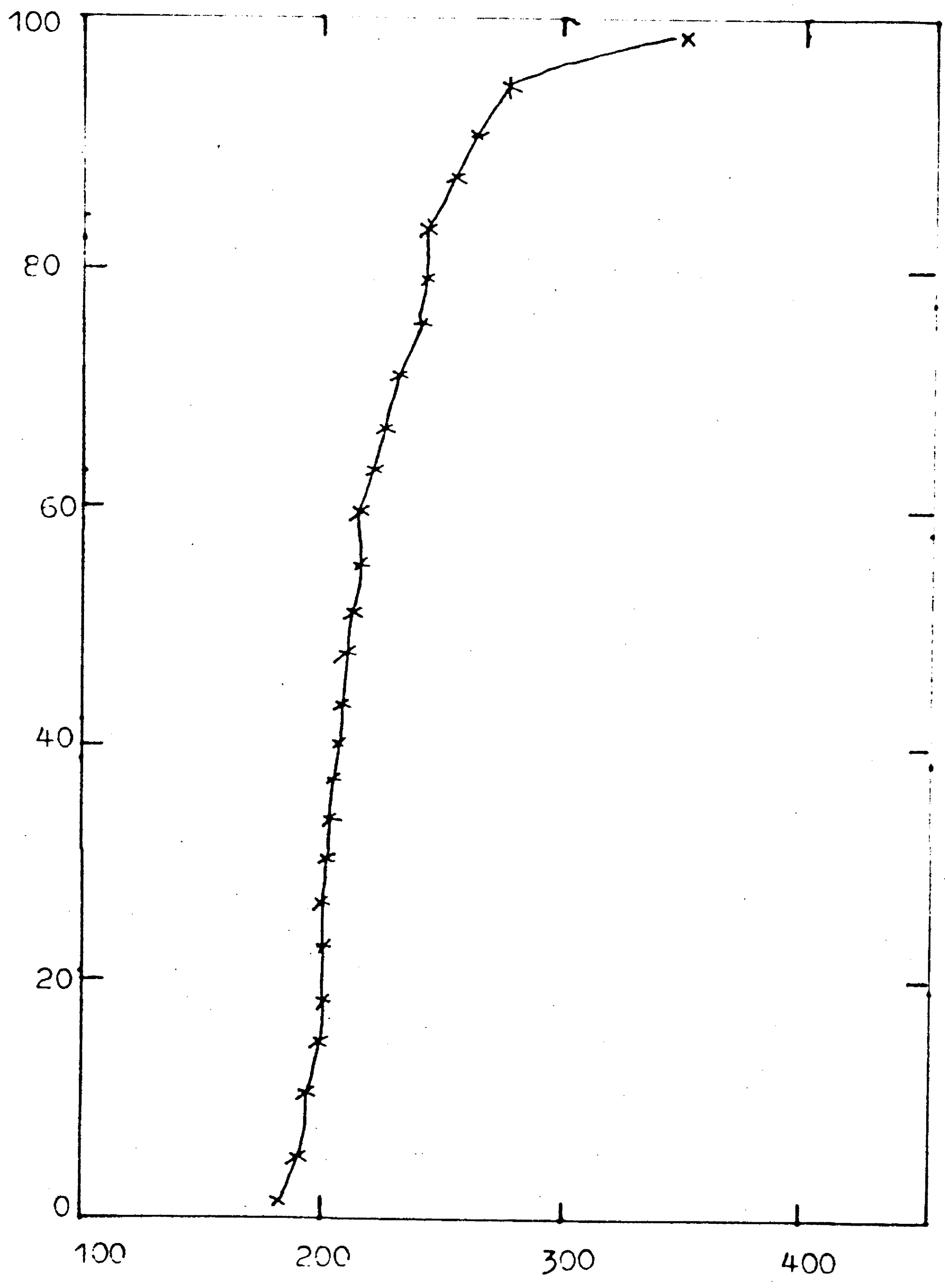
CANBERRA – 1932–1970, 35 COMPLETE YEARS, WINTER PERIOD (MAY–OCTOBER)

Source: Pierrehumbert (1974)



Source: Pierrehumbert (1974)

APPENDIX 6.2



RAINFALL (pt)

Californian Method - 25 highest 1 hour rainfalls observed at Cairns 1944 to 1968

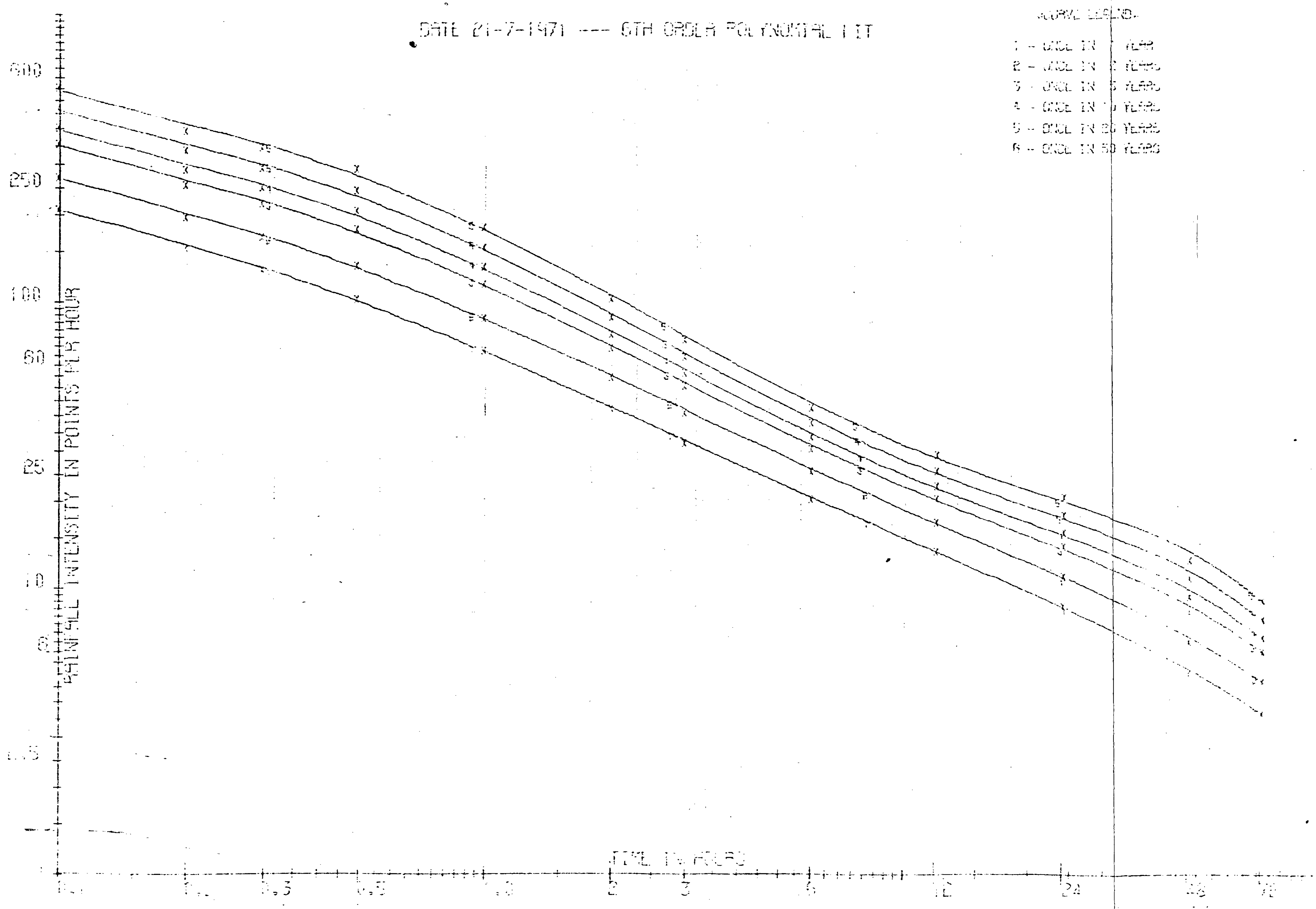
(After Pierrehumbert 1972)

RAINFALL INTENSITY DIAGRAM FOR

CANBERRA (YARRALUMLA) PLUVIO DATA - 1932 TO 1970 - 35 COMPLETE YEARS

PREPARED BY BUREAU OF METEOROLOGY -- MELBOURNE

DATE 21-7-1971 --- 6TH ORDER POLYNOMIAL FIT



APPENDIX 6.4

RAINFALL-DURATION-FREQUENCIES AT BULL'S HEAD LOWER COTTER CATCHMENT[1)]

Rainfall duration (mins)	Rainfall total in millimetres Frequency (once in) 1 yr.	2 yrs.	5 yrs.	10 yrs.	20 yrs.	50 yrs.	100 yrs.
6	7.5	10.1	14.9	18.0	22.1	27.4	31.8
12	11.3	15.2	22.1	26.5	32.3	39.8	46.0
18	14.5	19.5	28.7	34.6	42.4	52.4	60.9
30	18.6	25.2	37.5	45.7	56.3	70.0	81.6
60	23.6	31.8	46.9	56.8	69.7	86.2	100.2
120	28.8	38.0	52.8	61.8	73.7	88.7	101.1
180	33.0	42.6	56.1	64.0	74.5	88.8	101.2
360	43.5	54.5	65.9	71.8	80.5	90.9	101.3
720	58.7	72.8	85.6	92.0	102.0	113.6	122.7
1440	74.3	94.4	117.2	129.9	148.7	170.0	186.8
2880	83.1	108.7	144.2	166.4	199.2	235.0	267.2
4320	86.5	111.5	144.3	166.5	199.3	235.1	263.3

1) Number of complete years of record, 7. Period from 1965 to 1974

APPENDIX 6.5

RAINFALL-DURATION-FREQUENCIES AT BLUE RANGE

LOWER COTTER CATCHMENT[1)]

Rainfall duration (mins)	Rainfall total in millimetres						
	Frequency (once in)						
	1 yr.	2 yrs.	5 yrs.	10 yrs.	20 yrs.	50 yrs.	100yrs.
6	6.0	7.6	9.5	10.6	12.1	13.9	15.3
12	9.0	11.4	14.1	15.7	17.8	20.4	22.3
18	11.5	14.6	18.3	20.5	23.4	27.0	29.7
30	14.7	18.7	23.6	26.5	30.4	35.2	38.8
60	18.7	23.7	29.4	32.7	37.2	42.6	46.6
120	23.5	29.3	35.1	38.2	42.8	48.2	52.1
180	27.5	34.1	40.1	43.2	47.9	53.5	57.5
360	37.8	46.7	54.2	58.1	64.1	71.2	76.2
720	52.3	65.1	77.1	83.5	93.1	104.3	112.5
1440	66.5	84.2	103.4	113.9	129.6	147.2	161.4
2880	77.1	98.9	123.6	136.9	158.2	180.3	200.8
4320	87.5	112.5	138.5	151.6	175.3	197.4	221.5

1) Number of complete years of record, 7. Period from 1965 to 1974

RAINFALL TOTAL - DURATION - RAINFALL INTENSITIES, APRIL-NOVEMBER 1977

KYETMAUK-TAUNG CATCHMENT

(Extracted from analogue charts from pluviograph installed at Mt Poppa)

Date	Rainfall (mm)	Duration (mins)	Rainfall intensity (mm/hour)
7.4.77	2	15	8
25.5.77	10	6	100
	20	30	40
2.6.77	7	14	30
	16	45	21
12.6.77	17	25	41
15.6.77	7	25	17
18.6.77	13	12	65
7.7.77	4	22	11
	3	8	22
	2	5	24
4.8.77	10	30	20
	4	6	40
	4	15	16
	10	15	40
	5	5	60
23.8.77	7	8	52
	25	60	25
20.9.77	25	15	100
22.9.77	8	25	19
	6	8	45
25.9.77	6	15	24
4.10.77	4	3	80
	6	6	60
6.10.77	7	5	84
	14	15	56
16.10.77	10	8	75
	25	15	100
18.10.77	12	15	48
3.11.77	5	5	60
	5	4	75

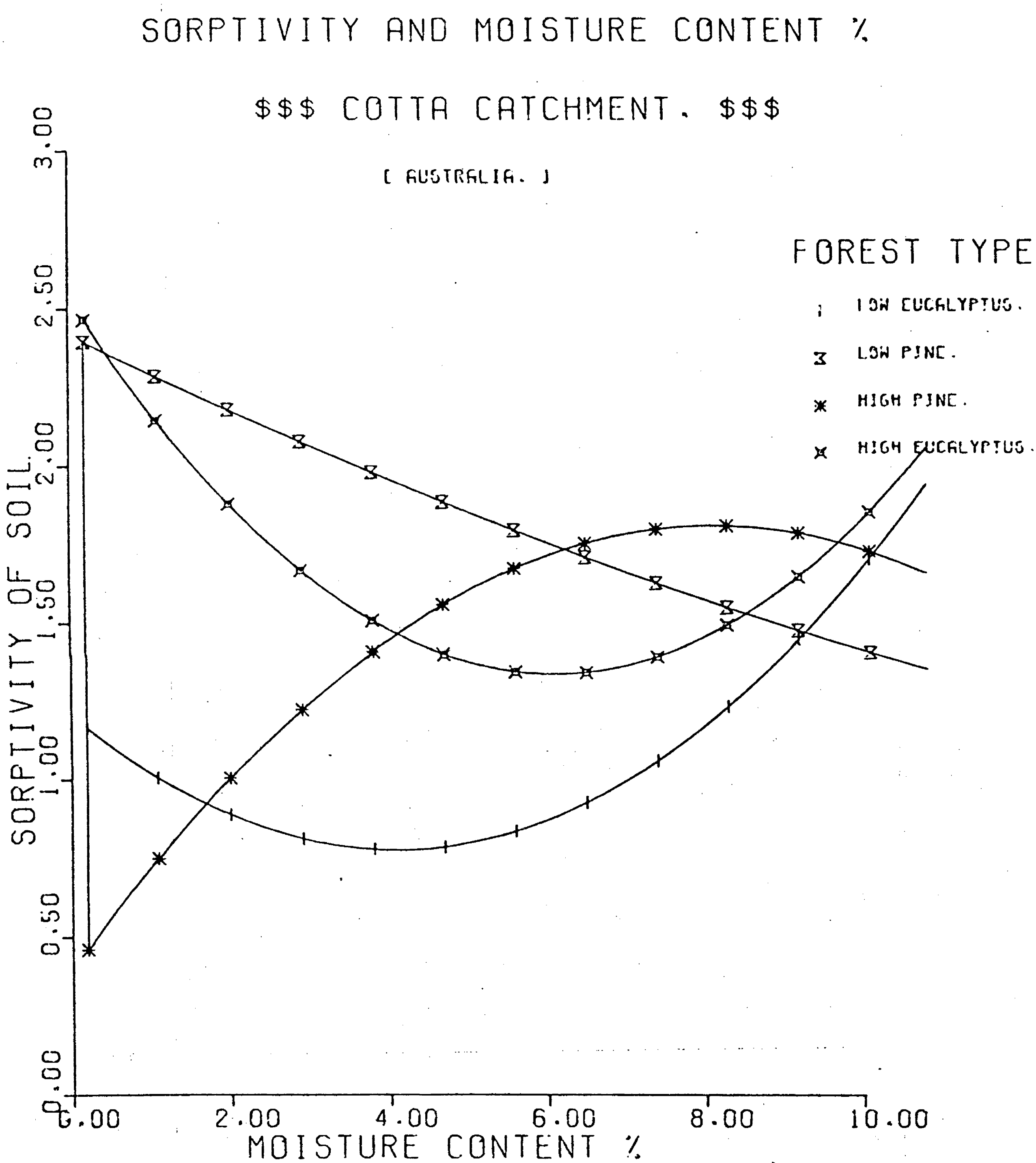
Regression Model : $Y = a X^{b}$, where Y = Cumulative Infiltration (Mean , Min or Max.), X = Time

Region : AUSTRALLA

Season :

Particulars	Type of Forest											
	High Eucalyptus Cumulative Infiltration			Low Eucalyptus Cumulative Infiltration			High Pine Cumulative Infiltration			Low Pine Cumulative Infiltration		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
1. Regression constant (a)	0.7187	1.8331	1.3759	0.4485	2.0591	1.3064	1.2903	1.9666	1.1792	0.6853	1.9091	1.2815
2. Log a	0.1434	0.2632	1.1386	0.3482	0.3137	0.1161	0.1107	0.2937	0.2251	0.1641	0.2808	0.1077
3. Regression coefficient (b)	0.7070	0.7358	0.6757	0.6596	0.6011	0.6324	0.6901	0.7187	0.6777	0.6747	0.7454	0.6936
4. Correlation coefficient between Log Y and Log X.	0.9994	0.9960	0.9974	0.9982	0.9977	0.9978	0.9978	0.9968	0.9974	0.9974	0.9964	0.9973

APPENDIX 7.1
Sheet 2 of 2



Regression Model : $Y = a X^{b}$, Where Y = Cumulative Infiltration (Mean , Max , or Min).

X = Time in Minute.

Region : BURMA

Season : Dry

Particulars	Type of Forest								
	Mixed Deciduous Cumulative Infiltration			Man - made Cumulative Infiltration			Semi - Indine Cumulative Infiltration		
	Min.	Max.	Mean	Min.	Max.	Mean	Min,	Max.	Mean
1. Regression Cons - tant (a).	1.2794	2.0367	1.6460	1.2039	1.7896	1.4893	0.8808	1.7331	1.3303
2. Log a	0.1070	0.3089	0.2164	0.0806	0.2528	0.1730	0.0551	0.2388	0.1240
3. Regression Coefficient (b)	0.6838	0.6766	0.6813	0.6766	0.6866	0.6736	0.6668	0.7131	0.6705
4. Correlation Coefficient between Log Y and Log X.	0.9984	0.9974	0.9974	0.9993	0.9960	0.9974	0.9975	0.9957	0.9974

Regression Model : $Y = a X^b$, where Y = Cumulative Infiltration (Mean , Max or Min).

X = Time in Minute.

Region : BURMA

Season : Wet

Particulars	Type of Forest								
	Mixed Deciduous Cumulative Infiltration			Man - made Cumulative Infiltration			Semi - Indine Cumulative Infiltration		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
1. Regression constant(a)	0.9672	1.8389	1.3402	1.1875	1.5831	1.3608	0.7956	1.4032	1.1218
2. Log a	0.0145	0.2646	0.1272	0.0746	0.1995	0.1338	0.0993	0.1471	0.0499
3. Regression Coefficient(b)	0.5364	0.5261	0.5307	0.5269	0.5241	0.5269	0.5269	0.5229	0.5243
4. Correlation coefficient between Log Y and Log X.	0.9996	0.9998	0.9997	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998

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